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YEAR BOOK

OF THE

Michigan College of Mines

1904-1905

ANNOUNCEMENT OF COURSES FOR 1905-1906

HOUGHTON, MICHIGAN

PUBLISHED BY THE COLLEGE
JUNE, 1905

[redacted]

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Calendar, 1905-1906

Fall Term begins Friday morning, September 29, 1905, and ends Friday noon, December 22, 1905—twelve weeks.

Examinations for admission and advanced standing begin Friday morning at 9 o'clock and continue through Friday and Saturday.

Regular work for all classes begins Monday, October 2, 1905, at 8 a. m. Full work is to be taken up at this time.

Thanksgiving Recess from Wednesday noon, November 22, until Monday morning, November 27, 1905.

Winter Term begins Monday morning, January 8, and ends Friday noon, March 23, 1906—eleven weeks.

Spring Term begins Monday morning, April 2, and ends Saturday evening, June 9, 1906—ten weeks.

Summer Term begins Monday morning, June 11, 1906, and ends Friday evening, August 31, 1906—twelve weeks.

Practical work in Mine Surveying and Mining begins Monday morning, May 7, and ends Friday evening, June 8, 1906.

Surveying begins Monday morning, June 11, and ends Thursday evening, August 30, 1906.

Shop Practice begins Monday morning, June 11, and ends Thursday evening, August 30, 1906.

Ore Dressing and Mechanical Laboratory Practice begin Monday morning, June 11, and end Friday evening, July 20, 1906.

Field Geology, Electrical Engineering Laboratory and Testing Materials of Engineering begin Monday morning, July 23, and end Thursday evening, August 30, 1906.

A Register of Graduates up to and including the class of 1903, giving their occupations, is published separately and will be sent upon request.

Michigan College of Mines

GENERAL STATEMENT

The Michigan College of Mines was established by an Act of the Legislature of 1885. The Act was entitled: "An Act to establish and regulate a Mining School in the Upper Peninsula." The Act vested the government of the institution in a Board of Control of six members appointed by the Governor of the State. Two members of the Board are appointed each alternate year to serve six years.

Sec. 5 provides that: "The course of instruction shall embrace geology, mineralogy, chemistry, mining, and mining engineering, and such other branches of practical and theoretical knowledge as will, in the opinion of the board conduce to the end of enabling the students of said institution to obtain a full knowledge of the science, art, and practice of mining, and the application of machinery thereto."

The school was opened for the reception of students September 15, 1886. Its establishment and the earlier appropriations for it are to a very large extent due to the great interest, the foresight and the energy displayed on its behalf by the late Jay A. Hubbell, of Houghton. He donated a large portion of the site occupied by the College, and during his life spared no effort to further its aims or to help it toward prosperity.

It will be seen that the institution is closing its 19th year, yet it can point to successful graduates in almost every mining district of North America. Most of its students have been from Michigan, since it is a Michigan institution, yet it has trained men from all parts of the United States, and from a number of foreign countries in both hemispheres.

The concentration of effort on the training of Mining Engineers, the location of the College in a district where its students live in a mining atmosphere, together with its special methods of instruction, and manner of using the mining environment, account for the success which this institution has attained.

The College was established for, and exists only for the purpose of training men to take an active part in the development of the mineral wealth of the state and nation. This concentration of effort on a particular line of training has its advantages. Many of the perplexing problems which arise where numerous lines of effort must be simultaneously proceeding are unknown in this institution. Here all work for a common object. Every employee has his share in whatever of success the College attains. This condition develops a spirit of harmonious endeavor which facilitates greatly the work of instruction.

The College has been particularly fortunate in the matter of its location. It is plain that an engineering school must derive immense advantage from a location in which its immediate surroundings continually illustrate and enforce the principles which it teaches. When the line of operations for which it is training its students is the dominant one of the region, obviously the advantage is greatest. Then the environment, even without effort on the part of the school, must serve as an efficient aid to the instruction. If those in control of these operations are in sympathy with the institution—are ready to place plants under their charge at its service for instruction, and if the institution makes wise use of opportunities thus afforded, these plants become truly a part of its equipment, and the environment then becomes a factor which must increase the efficiency of the instruction by an amount hardly to be overestimated.

The location of the Michigan College of Mines presents in a marked degree all these features. It is a location believed to be unique among the schools of mines in this country. The College is situated in the heart of the great copper mining region of Lake Superior.* Within a radius of eleven miles from its site are some twenty active copper mines. Several of the largest, most extensively equipped, and most successful metal mines in the world are among them. The deepest shafts in the world and the most powerful machinery ever employed in mining are here in constant operation. The aggregate horse-power of the engines employed by but two of these great mines exceeds the grand total of that of all the engines used in the gold and silver mines of the United States.

Besides the plants at the mines there are necessary docks, railroads, mills and smelters. To all the student has access, and he is required, under the direction and supervision of his instructors, to

*See map at end of yearbook.

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visit and inspect these plants and their operation at proper times during his study here. By being in such a district and being required to use its opportunities as he is, the student breathes from his arrival an atmosphere in entire harmony with his present and future work. He is continually inspired by observation of and contact with men who have achieved success in the line for which he is training. This location, together with the practical methods of training employed, account for the remarkable fact that of 283 men graduated up to this time, but four have left engineering for other pursuits.

The methods of instruction include the ordinary lecture, textbook and recitation work, supplemented in every department by problems drawn as far as possible from actual practice. Because the successful engineer must be a man whose judgment of *things* is well developed, laboratory methods of instruction are given great prominence. These include the trips of inspection to the mining plants in the vicinity, and the field and laboratory courses in which the student works with his own hands rather than watches the operations of some one else. In much the same way as the clinic serves to instruct the medical student, the inspection trips under the charge of the professor serve to train the mining student. But the medical student, if he can, gets in addition to his clinics, training in a hospital, where, under the proper supervision, he begins actual practice. So the student taking a mining engineering course should have his actual practice in the field or in properly arranged laboratories. This the College endeavors to give.

The facilities afforded for inspection trips and field work by the location of the College have already been mentioned. It is obvious that actual commercial operations, such as are witnessed on the inspection trips to the mining plants, afford most forceful illustration of the applications of principles which may be presented in textbooks or lecture. Necessarily also the nearer the field or laboratory practice is made to conform to commercial requirements, the more forcible its teachings and the more valuable the experience here gained. This point is attended to in the various practical field and laboratory courses given at this institution. The Ore Dressing course may be taken as an example. When the class at work in it are ready to begin milling, an ore is turned over to them after it has been assayed. They assay it and treat it. At proper intervals they assay the tailings, weigh up the product, and determine its

fineness. They are held responsible to the College for the metal in the ore just as mill operators would be. They meet as nearly as possible commercial conditions and requirements. As far as applicable the same plan is followed in all of the field and laboratory courses. Under the proper sub-heads in the section of the year-book devoted to "Departments of Instruction," and in the section headed "Buildings," will be found a more detailed description of the means possessed by the college for instruction in field and laboratory, as well as a more particular account of the manner of using the several parts of the equipment and the various features of the surroundings for the purpose of giving engineering training.

The field of mining engineering is so broad, and the number of subjects bearing on it so great, that no student can profitably cover all of the ground in the time usually given to a college course. Moreover, the average student possesses greater aptitudes in some part or parts of this broad field than in others. If he cannot train for all of it his chances of success are manifestly greater if he devotes himself to those portions for which he is best adapted. In order that he may do this, some way must be provided whereby different students may pursue different curriculums. To meet these conditions the Michigan College of Mines has put into operation a system allowing a wide range in selecting the courses or subjects which shall compose a particular student's curriculum. This does not mean that haphazard selection is allowed. A student desiring to pursue a certain line of work selects courses leading up to it. He is obliged to preserve the natural sequence of subjects. Having shown his bent and set out to train in accordance with it he follows an orderly system of selection which may become more and more specialized as he nears the end of his course. This college was the first, and until very recently the only institution to offer such privileges of choice to a student of engineering. Regulations governing the choice of courses under this system are given with other regulations of the College on a subsequent page.

The methods outlined above have not been carelessly thought out nor hastily adopted. They have developed slowly in the earnest effort of those interested in, and responsible for the institution to solve the problems presented to it, and to build up an efficient system of training mining engineers. Up to the present time they have stood the test of use very satisfactorily.

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BOARD OF CONTROL OF THE MICHIGAN COLLEGE OF MINES

	TERM EXPIRES
Hon. John Monroe Longyear, Marquette, - - -	June 9, 1907
William Edward Parnall, Calumet, - - -	June 9, 1907
William Kelly, Vulcan, - - - - - - -	June 9, 1909
James MacNaughton, Calumet, - - - -	June 9, 1909
Murray Morris Duncan, Ishpeming, - - - -	June 9, 1911
Lucius Lee Hubbard, - - - - - -	June 9, 1911

Chairman of the Board of Control, - - - WILLIAM KELLY

Secretary of the Board of Control, - - FRED WALTER MCNAIR

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OFFICERS OF ADMINISTRATION

President,	Fred Walter McNair
Secretary and Librarian,	Frances Hanna Scott
Treasurer,	Frederick William Nichols
Superintendent of Grounds,	Frederick William Sperr
Superintendent of Buildings,	Ozni Porter Hood

STAFF OF INSTRUCTION

FRED WALTER McNAIR, B.S. (University of Wisconsin),
President.

GEORGE AUGUSTUS KOENIG, M.E. (Polytechnikum, Karlsruhe), A.M., PH.D. (University of Heidelberg),
Professor of Chemistry.

FREDERICK WILLIAM SPERR, E.M. (Ohio State University),
Professor of Civil and Mining Engineering.

OZNI PORTER HOOD, M.S., M.E. (Rose Polytechnic Institute),
Professor of Mechanical and Electrical Engineering.

ARTHUR EDMUND SEAMAN, B.S. (Michigan College of Mines), Professor of Mineralogy and Geology.

JAMES FISHER, JR., E.M. (Michigan College of Mines),
Professor of Mathematics and Physics.

LEONARD STRONG AUSTIN, PH.B. (Yale University),
Professor of Metallurgy and Ore Dressing.

ELMER DANIEL GRANT, B.A. (Colgate University), M.A. (University of Chicago), Assistant Professor of Mathematics and Physics.

MRS. FRANCES HANNA SCOTT, Librarian and Secretary.

GEORGE LUTHER CHRISTENSEN, B.S. (Kansas State Agricultural College), Instructor in Mechanical Engineering.

FREDERICK ABRAHAM DELAY, B.S. (University of Wisconsin), Instructor in Mechanical and Electrical Engineering.

GEORGE WATSON COREY, B.S. (Michigan College of Mines),
Instructor in Mineralogy and Geology.

CLYDE HENRY SHOEMAKER, B.S. (Michigan College of Mines), Instructor in Civil and Mining Engineering.

JOHN CENTENNIAL McGRATH, B.S., M.E. (Purdue University), Instructor in Machine Shop.

GUSTAVE FERNEKES, B.S., PH.D. (University of Wisconsin),
Instructor in Chemistry.

CHARLES EDMUND HAIGLER, B.S. (Ohio State University), Instructor in Mathematics and Physics.

CLEMENT EUGENE ROOD, PH.B., PH.M. (Albion College), Instructor in Mathematics and Physics.

CHARLES GAMBLE SIMPSON, M.A. (Cornell College), Instructor in Mathematics and Physics.

FRED ALLEN JORDAN, B.S., E.M. (Michigan College of Mines), Instructor in Mathematics and Physics.

ARTHUR ALEXANDER KOCH, M.S. (University of Wisconsin), PH.D. (University of Basel), Instructor in Chemistry.

CHARLES FRANKLIN BOWEN, B.S. (B. Y. College of Utah), M.S. (University of Wisconsin), Instructor in Geology and Mineralogy.

EUGENE THOMAS HANCOCK, B.S. (University of Wisconsin), Instructor in Mineralogy.

CHARLES HAMILTON HOYT, B.S. (Dartmouth College), C.E. (Thayer College of Civil Engineering), Instructor in Civil and Mining Engineering.

DURWARD COPELAND, B.S. (Massachusetts Institute of Technology), Instructor in Metallurgy and Ore Dressing.

JAMES RICHARD JOHNSON, B.M.E. (Kentucky State College), Instructor in Wood Work.

FRANK BROWN WILSON, Assistant in Chemistry.

JOHN FRASER GRAHAM, Assistant in Civil and Mining Engineering.

ROBERT FRANKLIN WOOD, B.A. (Williams College), Assistant in Chemistry.

DAVID HENRY CAMPBELL, PH.G. (Massachusetts College of Pharmacy), Assistant in Geology and Mineralogy.

OCHA POTTER, Assistant in Mineralogy.

GEORGE HOWARD SUMNER, B.S., E.M. (Michigan College of Mines), Assistant in Mechanical Engineering.

JOHN PHILIP FURBECK, Assistant in Mechanical Engineering.

GEORGE SAGE BROOKS, B.S. (Michigan College of Mines), Assistant in Civil and Mining Engineering.

THOMAS EMANUEL RICHARDS, Assistant in Shop Practice.

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OTHER EMPLOYEES

HENRY GIBBS,
Purchasing Agent and Supply Clerk.

MISS CLARA PENBERTHY,
Stenographer.

HARRY SHARP,
President's Secretary and Accountant.

THOMAS EMANUEL RICHARDS,
Engineer.

MAXIME MORIN,
Carpenter.

FREDERICK CHARLES STRASSER,
Chief Janitor.

FACULTY

Fred Walter McNair, President.

George Augustus Koenig

Frederick William Sperr

Ozni Porter Hood

Arthur Edmund Seaman

James Fisher, Jr.

Leonard Strong Austin

Frances Hanna Scott, Secretary

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Admission to the College

1. Admission by Examination.

All students who desire to become candidates for a degree are admitted on examination in the following subjects:

English.—The examination in this subject is intended to test the candidate's ability to command good English. He will be required to write briefly on some subject assigned at the time.

Arithmetic and Metric System.

Bookkeeping.

Algebra, through Quadratic Equations.

Geometry—Plane, Solid and Spherical.

Physics.

Physical Geography or Elements of Astronomy.

2. Admission by Diploma.

Candidates who are graduates of the proper course of a high school accredited to this institution are admitted upon presentation of diploma, together with a record of the subjects pursued and grade obtained in each.

Application to be placed on the accredited list may be made by the principal or superintendent of the school, who shall send to the secretary of the College a copy of the courses of study and list of text-books employed. Copies of examinations which have been set, accompanied with papers which have been written by pupils in answer thereto, must also be forwarded to the College. The subjects covered by these papers must not be less than four, including Math-

Milwaukee Academy, Milwaukee, Wis.
Milwaukee East Side High School, Milwaukee, Wis.
Milwaukee South Side High School, Milwaukee, Wis.
Milwaukee West Side High School, Milwaukee, Wis.
Morgan Park Academy, Morgan Park, Ill.
Muskegon High and Hackley Manual Training Schools.
Negaunee High School.
Niles High School.
Northwestern Military Academy, Highland Park, Chicago, Ill.
Norway High School.
Oshkosh High School, Oshkosh, Wis.
Petoskey High School.
Phœnix High School, Phœnix, Ariz.
Port Huron High School.
Racine College, Racine, Wis.
Reed City High School.
Republic High School.
Rockford High School.
Rutger's College Preparatory School, Princeton, N. J.
Ryan High School, Appleton, Wis.
Saginaw East Side High School.
Saginaw West Side High School.
St. Johns Military Academy, Delafield, Wis.
San Antonio Academy, San Antonio, Tex.
Sault Ste. Marie High School.
Shattuck School for Boys, Faribault, Minn.
Steele High School, Dayton, Ohio.
Three Rivers High School.
Toledo Central High School, Toledo, Ohio.
Township High School, Evanston, Ill.
Township High School, Oak Park, Ill.
Traverse City High School.
University High School, Chicago, Ill.
Worcester Academy, Worcester, Mass.

Detroit Eastern High School.
Detroit Western High School.
Detroit University School.
Duluth High School, Duluth, Minn.
Edgerton High School, Edgerton, Wis.
Escanaba High School.
Ferris Institute, Big Rapids.
Flint High School.
Gladstone High School.
Grand Rapids Central High School.
Grass Lake High School.
Hadley High School.
Hancock High School.
Houghton High School.
Hyde Park High School, Hyde Park, Chicago, Ill.
Ionia High School.
Iron Mountain High School.
Ironwood High School.
Ishpeming High School.
Ithaca High School.
Janesville High School, Janesville, Wis.
Johnstown High School, Johnstown, Pa.
Kalamazoo High School.
Kansas City Manual Training High School, Kansas City, Mo.
Lake Linden High School.
L'Anse High School.
Lansing High School.
Ludington High School.
Manistee High School.
Manistique High School.
Marquette High School.
Menominee High School.
Michigamme High School.
Michigan Military Academy.

nineteen years of age who can show that they have been employed for at least two years in some position entailing responsibility. The College reserves the right to withdraw this offer at any time that it may deem best.

6. Special Students.

Persons who are not candidates for a degree, and who wish to take special studies, are permitted to do so upon giving satisfactory evidence that they are able to pursue with profit the courses they wish to take. If they subsequently desire to become candidates for a degree they must pass the required entrance examinations.

Since its organization the College has had many students of mature age who came for certain training which they considered necessary for their subsequent work. These have proved themselves excellent workers, and the College desires to extend to such persons every possible aid. It has assisted in this way numerous practical and active business men who have had years of previous experience, and it desires to continue a work from which valuable results have been obtained in the past.

3. Graduates of Colleges.

Graduates of approved colleges are admitted upon presentation of their diplomas or certificates of graduation. Courses taken at the other institution which may be the equivalent of courses offered here, will be credited toward a degree, under the following conditions: After an informal discussion of the previous work, which must satisfy the instructors from whom credit is asked, as to its scope and thoroughness, provisional credits are given. If the student's subsequent work in this College is satisfactory, the provisional credits are made permanent; if unsatisfactory, the student is assigned to such courses as are necessary to make up the deficiencies.

This method is considered to be fair to the student, to the college from which he came, and to this College.

4. Undergraduates of Colleges.

Undergraduates of other colleges must present certificate of honorable dismissal. Credits are given them under the same conditions as outlined for graduates.

5. Special Arrangement.

In many cases persons who have been engaged in practical work until upwards of nineteen years of age, desire to better their condition by obtaining an education which will be of practical use, but they are unable to take the time for a full high school course. Such men often prove to be among the best students, since they realize clearly the purpose of their work and the value of time. For their benefit the College will arrange with the principal or superintendent of any of its accredited schools a special course to cover a minimum of two years' work, and upon the student's completion of this course the College will accept him upon the recommendation of the principal or superintendent.

This arrangement will not be entered into for prospective students who are under nineteen years of age, and only for those over

B. PHYSICS.

The President, Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Simpson, Rood and Jordan.

B 1. Physics.
Twelve hours a week, twenty-one weeks. To count as eight-tenths of a credit. Must be preceded by, or accompanied with, A 1 (Algebra) and A 2 (Plane Trigonometry). Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, SIMPSON, ROOD and JORDAN.

B 4. Physics.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. Must be preceded by B 1 (Physics). Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, SIMPSON, ROOD and JORDAN.

B 2. Physical Measurements.
Twenty-four hours a week, five weeks. To count as four-tenths of a credit. Must be preceded by B 1 and B 4 (Physics). Professor FISHER and Assistant Professor GRANT.

B 5. Light.
Six hours a week, twelve weeks. To count as two-tenths of a credit. Must be preceded by B 1 (Physics). The PRESIDENT and Professor FISHER.

B 3. Electrical Measurements.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by C 1 (Analytic Mechanics). Professor FISHER.

C. MECHANICS.

Professor Fisher and Assistant Professor Grant.

C 1. Analytic Mechanics.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by, or accompanied with A 5 (Calculus). Professor FISHER and Assistant Professor GRANT.

Outline List of Courses of Instruction Arranged in Order of Sequence

A. MATHEMATICS.

Professor Fisher, Assistant Professor Grant, Messrs. Simpson, Rood, Haigler and Jordan.

A 1. Algebra.
Three times a week, thirty-three weeks. To count as one credit. Messrs. SIMPSON, ROOD, HAIGLER and JORDAN.

A 2. Plane Trigonometry.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by, or accompanied with, A 1 (Algebra). Messrs. SIMPSON, ROOD, HAIGLER and JORDAN.

A 3. Spherical Trigonometry.
Two times a week, sixteen weeks. To count as three-tenths of a credit. To be preceded by A 2 (Plane Trigonometry). Professor FISHER and Assistant Professor GRANT.

A 4. Analytical Geometry.
Four times a week, twenty-one weeks. To count as nine-tenths of a credit. To be preceded by A 2 (Plane Trigonometry). Messrs. SIMPSON, ROOD, HAIGLER and JORDAN.

A 5. Differential and Integral Calculus.
Four times a week, twenty-eight weeks. To count as eleven-tenths of a credit. To be preceded by A 4 (Analytical Geometry), and B 1 (Physics), and preceded by, or accompanied with, B 4 (Physics). Professor FISHER and Assistant Professor GRANT.

A 6. Introduction to Differential Equations.
Four times a week, five weeks. To count as two-tenths of a credit. To be preceded by A 5 (Calculus). Professor FISHER.

F 6. Synthetic and Theoretical Chemistry.
Eighteen hours a week, thirty-three weeks. To count as two credits. To be preceded by F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis), and W 3 (Mineralogy). Professor KOENIG.

G. METALLURGY.

Professor Austin, Mr. Copeland and Mr. Tuttle.

G 1. Assaying.
Lectures and recitations, once a week, sixteen weeks, and one hundred twenty hours laboratory work and recitations. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis), and W 2 (Mineralogy). Professor AUSTIN, Mr. COPELAND and Mr. TUTTLE.

G 2. Metallurgy.
Four times a week, twenty-eight weeks, and twenty-seven hours for excursions and reports on same. To count as eight-tenths of a credit. To be preceded by F 3 (Qualitative Analsis), and preceded by, or accompanied with G 1 (Assaying), and W 2 (Mineralogy). Professor AUSTIN.

G 3. Metallurgical Laboratory Practice.
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis), G 1 (Assaying), and preceded by, or accompanied with, G 2 (Metallurgy). Professor AUSTIN and Mr. COPELAND.

G 4. Metallurgical Designing.
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by, or accompanied by G 2 (Metallurgy), Q-6 (Graphical Statics), M 11 (Mechanical Engineering 11). Professor AUSTIN.

G 5. Metallurgical Organization.
Nine hours a week, twelve weeks, fall term. To count as three-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN.

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G 6. **Metallurgical Accounting.**
Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN.

G 7. **Practice Work in Metallurgy.**
Forty-five hours a week, three weeks, first half of summer term. Blast Furnace work. To count as five-tenths of a credit. To be preceded by G 3 (Metallurgical Laboratory Practice). Professor AUSTIN and Mr. COPELAND.

S. ORE DRESSING.

Professor Austin and Mr. Copeland.

S 2. **Ore Dressing.**
Two hours a week in class room, and *three hours a week* in Laboratory, sixteen weeks, winter term and first half of spring term. To count as four-tenths of a credit. To be preceded by W 2 (Mineralogy), and G 1 (Assaying). Professor AUSTIN and Mr. COPELAND.

S 3. **Practice Work in Ore Dressing.**
Forty-five hours a week, three weeks, first half of summer term. To count as five-tenths of a credit. To be preceded by S 2 (Ore Dressing) and Q 2 (Hydraulics). Professor AUSTIN and Mr. COPELAND.

M. MECHANICAL ENGINEERING.

Professor Hood, Messrs. Christensen, DeLay, McGrath, Johnson, Sumner, Furbeck, and Richards.

M 2. **Shop Practice.**
Forty-five hours a week, twelve weeks. To count as two credits. Messrs. MCGRATH and JOHNSON.

M 15. Mechanical Drawing.
Fifteen hours a week, twelve weeks. To count as six-tenths of a credit. Mr. DeLay, Mr. Sumner and Mr. Furbeck.

M 16. Machine Drawing.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). Mr. DeLay, Mr. Sumner and Mr. Furbeck.

M 1. Properties of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics) and F 1 (General Chemistry), and preceded by, or accompanied with, B 4 (Physics). Mr. Christensen.

M 5. Mechanical Engineering I.
Three times a week, twelve weeks. To count as four-tenths of a credit. Professor Hood.

M 11. Mechanical Engineering II.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. To be preceded by M 5 (Mechanical Engineering I.), M 15 (Mechanical Drawing), M 1 (Properties of Materials) and M 2 (Shop Practice). Professor Hood.

M 4. Mechanics of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by M 1 (Properties of Materials), and preceded by, or accompanied with, C 2 (Analytic Mechanics). Mr. Christensen.

M 6. Testing Materials of Engineering.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 4 (Mechanics of Materials). Professor Hood and Mr. Christensen.

M 10. Pumps and Pumping Machinery.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and preceded by, or accompanied with, C 2 (Analytic Mechanics). Professor Hood.

M 14. Air Compression and Air Machinery.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 10 (Pumps and Pumping Machinery). Professor Hood.

M 3. Design of Structural Joints.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by, or accompanied with M 4 (Mechanics of Materials). Mr. Christensen.

M 12. Mechanical Engineering III.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and preceded by, or accompanied with C 2 (Analytic Mechanics), and fall term of M 4 (Mechanics of Materials). Professor Hood.

M 13. Mechanical Engineering IV.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 12 (Mechanical Engineering III.). Professor Hood.

M 9. Mechanical Engineering Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 13 (Mechanical Engineering IV.). Professor Hood and Mr. Christensen.

N. ELECTRICAL ENGINEERING.

Professor Hood and Mr. DeLay.

N 1. Electrical Engineering.
Three hours a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and B 1 and B 4 (Physics). Mr. DeLay.

N 3. Electrical Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by N 1 (Electrical Engineering). Professor Hood and Mr. DeLay.

Q. CIVIL ENGINEERING.

Professor Sperr and Messrs. Shoemaker, Hoyt, Graham, Brooks and Schubert.

Q 4. Topographical Drawing.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. Messrs. SHOEMAKER, HOYT and GRAHAM.

Q 1. Surveying (Field Work).
Fifty hours a week, twelve weeks. To count as two and two-tenths credits. To be preceded by A 3 (Spherical Trigonometry), and Q 4 (Topographical Drawing). Professor SPERR and Messrs. HOYT, GRAHAM and SCHUBERT.

Q 5. Surveying (Office Work).
Nine hours a week, twelve weeks. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying). Messrs. SHOEMAKER and HOYT.

Q 6. Graphical Statics.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. To be preceded by B 1 (Physics), and by either Q 4 (Topographical Drawing) or M 15 (Mechanical Drawing). Messrs. SHOEMAKER, HOYT, GRAHAM and BROOKS.

Q 7. Engineering Design and Construction.
Twelve hours a week, sixteen weeks. To count as seven-tenths of a credit. To be preceded by M 15 (Mechanical Drawing) and Q 6 (Graphical Statics), and preceded by, or accompanied with, M 4 (Mechanics of Materials), and R 4 (Mining Engineering). Professor SPERR and Mr. HOYT.

Q 2. Hydraulics.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining), and preceded by, or accompanied with, A 5 (Calculus). Mr. HOYT.

Q 3. Hydraulics.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by Q 2 (Hydraulics) and M 5 (Mechanical Engineering I.). Professor SPERR and Mr. SHOEMAKER.

R. MINING ENGINEERING.

Professor Sperr and Messrs. Shoemaker, Hoyt, Graham, Brooks and Schubert.

R 1. Principles of Mining.
Eleven hours a week, sixteen weeks. To count as six-tenths of a credit. Excursions to the mines, etc. This subject is required of all candidates for the B.S. and E.M. degrees. To be preceded by, or accompanied with, Y 1 (Principles of Geology). Professor SPERR and Messrs. SHOEMAKER and GRAHAM.

R 2. Mine Surveying and Mining (Classroom Work).
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by Q 1 (Surveying) and R 1 (Principles of Mining). Professor SPERR and Mr. BROOKS.

R 3. Mine Surveying and Mining (Field Work).
Fifty-four hours a week, five weeks. To count as one credit. To be preceded by R 2 (Mine Surveying and Mining), except for students who enter for this study alone, who are required to be prepared in Algebra, Geometry, Trigonometry, and in the use of the transit and level. Professor SPERR, Messrs. HOYT, GRAHAM, BROOKS and SCHUBERT.

R 4. Mining Engineering.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by C 2 (Analytic Mechanics), R 3 (Mine Surveying and Mining), and Q 2 (Hydraulics), and preceded by, or accompanied with, M 4 (Mechanics of Materials). Professor SPERR.

R 5. Mine Management and Accounts.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by R 3 (Mine Surveying and Mining). Professor SPERR.

R 6. Mine Ventilation.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by M 5 (Mechanical Engineering I.) and Q 2 (Hydraulics). Professor SPERR.

V. BIOLOGY.

Professor Seaman and Mr. Hancock.

V 2. Palaeontology.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit.

W. MINERALOGY.

Professor Seaman, and Messrs. Hancock, Bowen and Corey.

W 4. Elementary Mineralogy and Crystallography.
Fourteen hours a week, twelve weeks, and *three hours a week* for sixteen weeks. To count as eight-tenths of a credit. Professor SEAMAN, and Messrs. COREY, HANCOCK and BOWEN.

W 1. Crystallography.
Nine hours a week, twelve weeks. To count as four-tenths of a credit. To be preceded by W 4 (Elementary Mineralogy and Crystallography). Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

W 2. Mineralogy.
Twelve hours a week, sixteen weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics), F 2 (Blowpipe Analysis), W 1 (Crystallography), and Y 1 (Principles of Geology). Professor SEAMAN, and Messrs. COREY, HANCOCK and BOWEN.

W 3. Advanced Mineralogy.
Six hours a week, twenty-three weeks. To count as five-tenths of a credit. To be preceded by W 2 (Mineralogy), and preceded by or accompanied with X 2 (Petrography). Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

X. PETROGRAPHY.

Mr. Corey and Mr. Bowen.

X 1. Petrography.
Nine hours a week, twenty-eight weeks. To count as eight-tenths of a credit. To be preceded by Y 1 (Principles of Geology), and preceded by, or accompanied with, B 5 (Light), and W 4 (Elementary Mineralogy and Crystallography).

X 2. Advanced Petrography.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by X 1 (Petrography), and preceded by, or accompanied with W 3 (Mineralogy).

Y. GEOLOGY.

Professor Seaman, and Messrs. Corey, Bowen and Hancock.

Y 1. Principles of Geology.
Two times a week, twelve weeks, and *one time a week,* sixteen weeks. To count as four-tenths of a credit. To be preceded by, or to accompany, W 4 (Elementary Mineralogy and Crystallography). This subject is required of all candidates for B.S. and E.M. degrees. Professor SEAMAN, and Messrs. COREY and BOWEN.

Y 3. Physical and Chemical Geology.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by W 2 (Mineralogy), and preceded by, or accompanied with X 1 (Petrography). Professor SEAMAN and Mr. COREY.

Y 2. Historical Geology.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology). Professor SEAMAN and Mr. HANCOCK.

Y 4. Geological Field Work.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by Q 1 (Surveying), and Y 2 (Historical Geology). Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

Y 5. Economic Geology.
Three times a week, twenty-eight weeks. To count as nine-tenths of a credit. To obtain credit in this subject, it is necessary to have credit in W 3 (Mineralogy), X 2 (Petrography), and Y 4 (Geological Field Work).

J. THESIS.

The Faculty.

J 1. Thesis.

Properly qualified students may include the preparation of a thesis in their work for a degree. To count as one credit.

The subject of such thesis must be announced with the schedule of studies for the year in which the degree is expected; further, the schedule must be approved by the head of the department in which the thesis work is to be done. This approval will include the subject chosen and the student's preparation to do the work.

The schedule and subject are then considered by the Faculty, whose approval is necessary.

The thesis must be completed by July 1, and submitted to the Faculty for examination and acceptance. For its acceptance it must be accompanied with a written approval of the instructors under whom the work was done.

Departments of Instruction

A. MATHEMATICS.

Professor Fisher, Assistant Professor Grant, Messrs. Simpson, Rood, Haigler and Jordan.

As will be seen by a detailed examination of the following pages, the subjects of this department form the necessary foundation for a great part of the student's subsequent work; and they are given as a preparation for this work, as well as for their value in actual engineering practice, and in affording mental discipline.

It is the intention, therefore, to give the instruction in this department in such a manner as will make prominent those subjects or portions of subjects which will be of actual use to the student, and, later, to the engineer. The value of the study of mathematics in developing the power to do vigorous and logical thinking is not underestimated, but it is thought that the effort to master the logic of the subjects necessary to the engineer will afford the student ample opportunity to develop this power.

Every effort is made to see that the student takes advantage of the opportunity thus offered. At each step of his progress he is required to think. The ability to describe a given method, or to correctly quote a given formula, and to apply either to a given case, is in no instance accepted as sufficient. The student is required to logically derive the method or formula, and to demonstrate its correctness.

The courses offered in mathematics are the following:

A 1. Algebra.

Messrs. Simpson, Rood, Haigler and Jordan.

The course includes the Theory of Limits, Logarithms, Progressions, Binomial Theorem, Undetermined Co-efficients, Series and the solution of higher equations. Special attention is paid to the

slide rule, graphical solutions, and practical applications. Wentworth's College Algebra is used as the text book.

Three times a week, thirty-three weeks. To count as one credit.

A 2. Plane Trigonometry.

Messrs. SIMPSON, ROOD and HAIGLER.

The ratio system is used exclusively, and prominence is given to the solution of trigonometric equations, and the transformation of trigonometric expressions. The fall term's work in A 1 (Algebra) must precede or be taken along with this course. Wells's Plane and Spherical Trigonometry is used as the text book.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit.

A 3. Spherical Trigonometry.

Professor FISHER and Assistant Professor GRANT.

Under this head is given the solution of Right and Oblique spherical triangles with application to the simpler problems of Spherical Astronomy, such as the student will need in his surveying.

The text used is the same as A 2 (Plane Trigonometry).

Two times a week, winter term and first five weeks of the spring term. To count as three-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry).

A 4. Analytic Geometry.

Messrs. SIMPSON, ROOD, HAIGLER and JORDAN.

The course covers the straight line, conic sections, a few higher plane curves, transformation of co-ordinates, general equations of the second degree, and an introduction to geometry of three dimensions. The object is to familiarize the student with methods rather than with any set of curves. Given partly by lectures and partly from Tanner & Allen's Analytic Geometry.

Four times a week, twenty-one weeks, winter and spring terms.

To count as nine-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry), and preceded by, or accompanied with A 1 (Algebra).

A 5. Differential and Integral Calculus.

Professor FISHER and Assistant Professor GRANT.

The Differential Calculus is developed from a rate as its fundamental notion. The Integral Calculus is from the beginning treated as a method of summation. The object of the course is to give the student a thorough working knowledge of the subject, to put him in possession of a tool of which he can afterward make efficient use. It is believed that this can best be accomplished by giving him a rigorously logical basis for his methods and formulas; and the attempt to do this is therefore made. Applications of differentiation to Expansion in Series, Indeterminate Forms, Maxima and Minima, etc., are treated; while problems of Area, Volume, Work, Pressure, etc., introduce the subject of integration, and their treatment is carried along simultaneously with that of methods. Approximate methods of integration, including the polar planimeter, receive particular attention.

The Calculus is given by lectures, with printed notes, and Taylor's Differential and Integral Calculus as a text book. *Four times a week,* twenty-eight weeks, fall, winter and first half of spring terms. To count as eleven-tenths of a credit. Must be preceded by A 4 (Analytic Geometry), and B 1 (Physics), and preceded by, or accompanied with B 4 (Physics).

A 6. Introduction to Differential Equations.

Professor FISHER.

An introduction to Differential Equations, which includes the treatment of those special equations which the student will meet in his study of Mechanics and Electricity.

The course is given by lectures and recitations. *Four times a week,* last five weeks of the spring term. To count as two-tenths of a credit. Open to those who have credit for A 5 (Calculus).

B. PHYSICS.

The President, Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Simpson, Rood and Jordan.

The aim in the department of Physics, as in that of Mathematics, is to select such objects as have, directly or indirectly, a bearing on the practical work of the mining engineer, and to treat these in as practical a manner as possible. The instruction is given by the laboratory method. The student goes at once into the laboratory, and there, under the direction of the instructors, experiments for himself. The experiments are mostly quantitative.

So far as possible, mere mechanical following of direction is excluded, and intelligent thinking is made necessary to the accomplishment of the work. Every effort is put forth to have the student clearly develop and fix in his mind the principles of Physics which he will afterward use, and also to lay the foundation for that skill in accurate determination of quantity and care of delicate apparatus which are needed by the practical engineer. Accuracy and order are insisted on from the first. Each student receives individual attention, and, with the exception of a few experiments requiring more than one observer, he does his work independently of all other students.

The work of the laboratory is accompanied by illustrated lectures, and by text-book and recitation work.

The department is equipped with a good assortment of modern apparatus for lecture illustration and individual experiment.

B 1. General Physics.

Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Simpson, Rood and Jordan.

An elementary course including Mechanics, Heat and Light. Lecture, recitation and laboratory work proceed together throughout the course. Text books are Lock's Mechanics for Beginners, Glazebrook's Heat and Light, Sabine's Laboratory Manual, and printed notes issued by the Department. The geometrical side of Light is developed mostly in the laboratory, the wave theory in the lecture room with the optical lantern and the arc light.

Twelve hours a week, twenty-one weeks, winter and spring terms. To count as eight-tenths of a credit. Must be preceded by, or accompanied with A 1 (Algebra) and A 2 (Plane Trigonometry).

B 2. Physical Measurements.

Professor FISHER and Assistant Professor GRANT.

A more advanced course in measurements of precision, open to those who have taken B 1 and B 4 (Physics). The work offered will be mainly in the determination of densities, moments of inertia, calorimetry and photometry. Each student will work independently of all others, and to a considerable extent the choice of the line of work he is to pursue will lie with him. Text books are Nichol's Manual of Laboratory Physics, and Stewart and Gee's Elementary Practical Physics, Vols. I and III.

Twenty-four hours a week, last five weeks of the spring term. To count as four-tenths of a credit.

B 3. Electrical Measurements.

Professor FISHER.

The increasing use of electricity in mining and related industries has caused the Michigan College of Mines to give particular attention to this subject.

This course is offered to those who are making Electrical Engineering their principal subject, to those who intend taking up Electrolytic or Electro-metallurgical work, and to any others who wish to become familiar with those modern methods of electrical measurement necessary wherever there is made any practical application of this agent.

In the course are included the measurement of Current, Resistance, Potential Difference, Electromotive Force, Quantity, Capacity, Mutual and Self Induction, Strength of Field, etc.

In the lecture room the theory of a given measurement is taken up; then the construction and calibration of the instrument used in the measurement are studied, the instrument being at hand for inspection; and, finally, in the laboratory, the student calibrates, if necessary, and uses the instrument in making the measurement.

Examples of all the principal instruments used in modern elec-

trical methods are owned by this institution, and are available for the work of this course.

The text books are Carhart and Patterson's Electrical Measurements, and Nichol's Laboratory Manual.

Nine hours a week, sixteen weeks in the winter and first five weeks of spring terms. To count as five-tenths of a credit. To be preceded by C 1 (Analytic Mechanics).

B 4. General Physics.

Professor FISHER, Assistant Professor GRANT, Messrs HAIGLER, SIMPSON, ROOD and JORDAN.

Subject B 4 continues the work begun in B 1, and includes Heat and an elementary course in Magnetism and Electricity. Text books used are Glazebrook's Heat and Light, printed notes on Magnetism and Electricity, and Jackson's Electricity and Magnetism.

Twelve hours a week, twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics).

B 5. Light.

The PRESIDENT and Professor FISHER.

A more advanced course continuing the work begun in this subject in B 1 (Physics). The course is designed particularly for those students who desire to take up Petrography. It deals chiefly with polarization. The subject is presented by experimental lectures which are followed up with individual experiment. A very complete outfit of projection apparatus made by Newton & Co., London, is in the possession of the department for use in this course.

Six hours a week, twelve weeks. Fall term. To count as two-tenths of a credit. To be preceded by B 1 (Physics).

C. MECHANICS.

Professor Fisher and Assistant Professor Grant.

An attempt is made in Mechanics to develop the essential principles, and to render the student proficient in applying them to practical rather than theoretical problems. To this end a large

number of problems are solved which, so far as possible, are selected from machines or structures with which the student is already familiar, or the study of which he is subsequently to take up.

C 1. Analytic Mechanics.

Professor FISHER and Assistant Professor GRANT.

Church's Mechanics of Engineering, Parts I and II, Statics and Dynamics, is made the basis of this and the following course.

Subject C 1 occupies three hours in class room and three in the Laboratory each week for sixteen weeks, in the winter and first half of spring terms. To count as five-tenths of a credit.

To be preceded by B 1 (Physics), and preceded by, or accompanied with A 5 (Calculus).

C 2. Analytic Mechanics.

Professor FISHER and Assistant Professor GRANT.

Subject C 2 continues the work begun in C 1, and is given three hours in class room and three in the laboratory each week, twelve weeks, in the fall term. To count as four-tenths of a credit.

To be preceded by C 1 (Analytic Mechanics).

F. CHEMISTRY.

Professor Koenig, and Dr. Fernekes, Dr. Koch, Mr. Wilson and Mr. ....

The instruction in General and Experimental Chemistry is designed to excite in the student a love for experimentation and to train him to inductive thinking. If this aim can be reached, or if it can only be approximated, it is believed that the gain to the student will be great, much greater than that from the accumulation of any number of facts. All modern advancement in the subjugation of Nature's forces is owing to experiment, and we know from the autobiographical statements of many inventors of genius, that they lost the labor of years through the lack of training in properly correlating the results of their experiments.

In carrying out the plan of this course it has been found necessary and useful to abandon the use of text books altogether. For no matter how a text book be written and arranged, it will present to the beginner the science of chemistry as a finished edifice, very wonderful and very intricate in its details. The study of it thus becomes of necessity mechanical; the memory is loaded with facts and figures, and the thinking faculties become numbed rather than quickened. Experience of years has shown, that even a set of notes will have a similar effect on the student. The best results are obtained when the teacher builds up the science from experiment, by making suggestions leading the student to experiment on similar bodies in his own way. In this course there are no definitions of atoms, molecules and structural formulæ to start with. By means of a proper selection of common bodies, the student not only discovers the qualitative and quantitative relations of matter, the simple and compound bodies, but he produces his very reagents as he goes along; he comes to compare and correlate the phenomena; he finally classifies the phenomena, and works up to the evolution of their laws. It is not claimed that any and all brain organizations will become thinking instruments under this system. But it is claimed that it will greatly stimulate and improve existing faculties.

EQUIPMENT OF THE LABORATORIES.

The *Laboratory for General and Experimental Chemistry* is a room 31½ x 51 feet, situated in the basement of the northeast wing of the Chemistry building. The room receives light from three of its sides. Five desks provide table and closet space for ninety students. A continuous hood runs around three walls of the room with a total length of 102 feet, enabling forty-five students to make use of the hood at one time. The north wall hood is six feet high and is made fire proof. Here all experiments requiring high temperature are performed in wind furnaces, muffle furnaces and gas furnaces. The instructor's private room opens into the main laboratory. Another adjoining room contains all the special apparatus, which is accessible to the students through the instructor.

The *Laboratory for Qualitative Analysis* occupies the west wing of the main floor. The room is 40 x 33 feet. Five desks give working and closet space for sixty-four students, with one sink for

four places. A continuous hood runs along three of the walls. This hood is divided into compartments of five feet each, to be occupied by one or two students at a time. Each compartment contains two permanent self-supplying water-baths and two gas stop-cocks. Four of the compartments have two Koenig's Hydrogen-sulfid generators, each permanently mounted. The hoods are supplied with mains for water, gas and compressed air, the latter to be used chiefly for rapid evaporation on the water baths; from each compartment the foul gases and vapors are drawn by fan-suction whilst a large volume of fresh air of the proper temperature is constantly blown into the room by a pressure fan. A dark room for spectroscopic work, and the instructor's office, open into this laboratory.

The *Laboratory for Quantitative Analysis* occupies the east wing of the main floor. It is 39½ x 33 feet. Four desks accommodate forty students; allowing each man four feet, and a sink for every four men. A hood runs along each of the long sides, divided into compartments and furnished the same as in the Qualitative Laboratory, except that two compartments only contain Koenig's Hydrogen-sulfid generators, whilst two other compartments are furnished each with a Koenig's Chlorine and Hydrogen generator, a combustion furnace and a Shimer apparatus for carbon determinations. The weighing room opens directly into the laboratory, but it has exclusive northern light. It is furnished with twelve analytical balances of the best make; one for four students. The laboratory for *Gas Analysis* is located alongside of the weighing room. It has light from the north only and can be kept at a uniform temperature. It is furnished with Hempel's and Bunsen's apparatus, both for working over water and working over mercury. The instructor's office and the *Electrolytic* room adjoin the laboratory on the south wall. The electrolytic room contains desks for electrolytic determinations with six working spaces, each of which is furnished with a separate resistance, a voltmeter and a milli-am-meter. In this room is the Glass-Blower's table.

The *Laboratory for Advanced Quantitative Analysis* has working facilities for eight students. But there is a laboratory for special work in which synthetic work and research work can be carried on by a few students. This laboratory is located alongside the professor's office on the main floor.

The class instruction is given in a spacious lecture room, which

is located at the east end of the second floor. This room seats 132 students in nine rows, each row being three inches higher than the preceding one. The lecture desk is furnished in the modern manner, with the electric current, and switch-board arrangements, also with water, gas and compressed air. The desk is unobstructed by any hood. Experiments generating noxious gases are carried on in a hood which stands in the adjoining preparation room behind a movable glass panel. When the latter is raised the apparatus under the hood will be visible from all parts of the room. Provision is made for the display of charts and diagrams in front of and above the black-boards behind the lecture table.

The supply clerk's office and store-rooms are located in the basement, but are connected with the main floor by means of a dumb waiter.

F 1. General Experimental Chemistry.

Professor Koenig and Mr. Wilson.

Twelve hours a week, twenty-eight weeks; one recitation, three lectures, and six hours of laboratory work each week; to count as eleven-tenths of a credit.

The instruction in this subject covers the following ground:

First. Experiments with the common metals, their action when heated in air, and when heated in the absence of air; discovery of the composite nature of air; a life sustaining part (ozone); a life destroying part (azote). Specific gravity of azote by direct weight and of ozone by calculation. The increase in weight of metals when heated in air, discovery of ozonites (oxides). Ratio of increase. Burning of sulphur in air, discovery of a gaseous sulphur ozonite possessing an acid taste; change of the name ozone into oxygen. Restoration of the original metals from the oxyds by the action of charcoal; hence the notion of elements or simple bodies. Action of the common metals at a red heat upon steam, the forming of bodies similar to the oxides and of an inflammable gas; discovery of hydrogen and its properties. Proving the identity of water oxides with air oxides, hence the conclusion that water is a combination of oxygen with hydrogen.

Second. (1) The study of copperas or vitriol. Under the action of heat it yields an oily liquid—the oil of vitriol. Correlation

of this body with sulphur oxide. With the oil of vitriol the student has gained now a powerful reagent, but he does not know, and should not be told at this stage of his development that this oil of vitriol is $H^2 SO^4$. The body is for his purposes simply oil of vitriol, for which the symbol Ov may stand.

(2) Study of potash, soda ash, limestone. Their action with heat, with heat and charcoal, with oil of vitriol. Their action upon each other; of burnt lime upon potash. Discovery of potassium, sodium, calcium, of caustic soda, caustic potash, and of a non-life-sustaining, heavy, slightly sour gas, lime gas (not CO_2). Alkaline reaction, acid reaction; the notion of hydroxides, of acid hydroxides and of basic hydroxides.

(3) Study of common salt, the mother-liquor salt, and the varec salt; the spirits of salt. Decomposition into a green gas and hydrogen. Chlorine probably a simple body. Bromine, iodine, fluorine. Action of chlorine upon hydrogen in equal volumes. The theory of combinations by volumes; the notion of *molecules* and *atoms;* of molecular weights and atomic weights. The action of chlorine upon the common metals—the chlorides, their properties. Reproduction of salt by acting with spirits of salt upon soda-ash—hence the identity of the metal in salt and soda-ash. Atomic weight of sodium and potassium by experiment.

(4) The study of nitre. Action in heat. Yields a gas which sustains combustion and animal breathing. Identification of this gas with the ozone or oxygen of the air. The notion of super or peroxides. The spirits of nitre. Its action upon the metals. Discovery of nitrogen and identification of this gas with the ozote of the air. The several oxides of nitrogen. Nitrogen chloride. Action of zinc and caustic potash upon nitre. Discovery of gaseous alkaline body: Ammonia. Study of its properties and combinations; ammonium salts.

(5) The study of sulphur. The oxides and chlorides of sulphur. The manufacture of hydrogen sulphate.

(6) Discovery of carbon by decomposing the limestone gas with sodium. Identification of this body with the substance of charcoal, of mineral coal, of plant and animal structures. The mineral oils, the natural gases. The fats, alcohols, ethers, albumenoid bodies. Discovery of cyanogen and its principal compounds.

(7) The study of bone-ash and discovery of phosphorus-oxides and hydroxides of phosphorus.

(8) The study of borax and quartz; borum and silicon.

(9) Theoretical deductions. Electrolysis. Thermo-chemistry. Structural and stereographic formulæ.

The students are required to take notes during the lectures, and they must keep a detailed account of their own observations and deductions in the laboratory. The term standing is derived from these notes and from the recitations, which are held once a week.

F 2. Blowpipe Analysis.

Professor Koenig, Dr. Koch and Mr. Wilson.

Twelve hours a week, five weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as two-tenths of a credit. The lectures are merely a continuous set of demonstrations by the professor to show how the reactions should be made.

This is a short course in Qualitative Analysis in which preference is given to reactions in the igneous way, so that students may be enabled to take the course in Mineralogy with full benefit.

Brush's tables and Landauer's small treatise are referred to.

To be preceded by F 1 (General Chemistry).

F 3. Qualitative Analysis.

Professor Koenig and Dr. Koch.

Twelve hours a week, twenty-eight weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as eleven-tenths of a credit. To be preceded by F 1 (General Experimental Chemistry) and F 2 (Blowpipe Analysis).

This course embraces the chemistry of the metals and their technically important salts. In the case of gold, for instance, the student receives 200 mgrs. of the pure metal and after having converted it into the prescribed compounds and studied the reactions, he must return the gold as pure metal. As this is time-taking the course has been extended beyond the usual limit.

F 4. Volumetric Analysis.

Professor KOENIG and Dr. FERNEKES.

Twelve hours a week, for twelve weeks. To count as five-tenths of a credit. Two lectures and one recitation a week. To be preceded by F 3 (Qualitative Analysis).

The course comprises: Alkalimetry, acidemetry. Volumetric analysis of limestone and marl. Analysis of copper ores by gravimetric, volumetric, colorimetric and electrolytic methods in order that the student may learn their relative merits. Permanganate, dichromate and iodometric methods.

Sutton's Volumetric Analysis for reference.

F 5. Advanced Quantitative Analysis.

Professor KOENIG.

Twelve hours a week, thirty-three weeks. One lecture, one recitation and eight hours of laboratory work a week. To count as twelve-tenths of a credit.

This course embraces: the analysis of fats, oils and soaps; the extraction and estimation of poisons; the analysis of fertilizers; the analysis of explosives; the estimation and separation of the rare elements in minerals; analysis of samarskite; nitrometry, and oxygenometry. Gas Analysis, according to Bunsen, Hempel and Winkler. Theoretical chemistry.

To be preceded by, or accompanied with F 7 (Quantitative Analysis).

F 6. Synthetic and Theoretical Chemistry.

Professor KOENIG.

Eighteen hours a week, thirty-three weeks. To count as two credits. Candidates must have completed subjects F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis) and W 3 (Mineralogy).

This course is intended as an amplification of the course in

(7) The study of bone-ash and discovery of phosphorus-oxides and hydroxides of phosphorus.

(8) The study of borax and quartz; borum and silicon.

(9) Theoretical deductions. Electrolysis. Thermo-chemistry. Structural and stereographic formulæ.

The students are required to take notes during the lectures, and they must keep a detailed account of their own observations and deductions in the laboratory. The term standing is derived from these notes and from the recitations, which are held once a week.

F 2. Blowpipe Analysis.

Professor KOENIG, Dr. KOCH and Mr. WILSON.

Twelve hours a week, five weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as two-tenths of a credit. The lectures are merely a continuous set of demonstrations by the professor to show how the reactions should be made.

This is a short course in Qualitative Analysis in which preference is given to reactions in the igneous way, so that students may be enabled to take the course in Mineralogy with full benefit.

Brush's tables and Landauer's small treatise are referred to.

To be preceded by F 1 (General Chemistry).

F 3. Qualitative Analysis.

Professor KOENIG and Dr. KOCH.

Twelve hours a week, twenty-eight weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as eleven-tenths of a credit. To be preceded by F 1 (General Experimental Chemistry) and F 2 (Blowpipe Analysis).

This course embraces the chemistry of the metals and their technically important salts. In the case of gold, for instance, the student receives 200 mgrs. of the pure metal and after having converted it into the prescribed compounds and studied the reactions, he must return the gold as pure metal. As this is time-taking the course has been extended beyond the usual limit.

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This course embraces: the analysis of fats, oils and soaps; the extraction and estimation of poisons; the analysis of fertilizers; the analysis of explosives; the estimation and separation of the rare elements in minerals; analysis of samarskite; nitrometry, and oxygenometry. Gas Analysis, according to Bunsen, Hempel and Winkler. Theoretical chemistry.

To be preceded by, or accompanied with F 7 (Quantitative Analysis).

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This course is intended as an amplification of the course in

General Chemistry, to cultivate the field of original discovery and invention; to produce with known reactions a desired commercial result. The modern theories based upon the physico-chemical researches of late years are to be fully discussed and compared with former notions upon the constitution of chemical compounds. Students who wish to take this course must have shown by their previous work that they possess the required originality of mind and practical sense. To all others it is a waste of time. The students are required to read much chemical literature and to discuss their reading in a seminar to be appointed from time to time. The subjects of experimentation may either originate with the student or may be suggested by the professor.

The student must keep a minute account of all his work, in arranging the apparatus, as well as in the actual experiment, whether the latter be a failure or a success.

F 7. Quantitative Analysis.

Professor KOENIG and Dr. FERNEKES.

Twelve hours a week, twenty-one weeks; two lectures and one recitation a week. To count as nine-tenths of a credit.

Course embraces: (1) Analysis of iron ores. The sample is made up to contain all the elements likely to be of importance in iron ores. In the soluble portion are to be determined volumetrically iron, copper, manganese, phosphorus, sulphur. In the insoluble portion are determined the oxides SiO_2, TiO_2, Cr_2O_3, Fe_2O_3, CaO and MgO by gravimetric methods. (2) Analysis of Pig Iron and Steel, including colorimetric estimation of carbon and manganese. (3) Analysis of Matte and Speiss, embracing the separations of arsenic, antimony, tin, bismuth, silver, copper, cadmium, zinc and iron.

The lecture notes serve as a guide, but the student is referred to the digests of Fresenius, Classen, E. F. Smith.

To be preceded by F 4 (Volumetric Analysis).

G. METALLURGY.

Professor Austin, Mr. Copeland and Mr. Tuttle.

G 1. Assaying.

Professor Austin, Mr. Copeland and Mr. Tuttle.

Lectures and recitations *once a week*, sixteen weeks, winter and first half of spring terms, and one hundred twenty hours of laboratory work, including half-hour daily recitations. To count as five-tenths of a credit. To be preceded by subjects F 3 (Qualitative Analysis) and W 2 (Mineralogy).

The Fire-Assaying comprises: Assay of ores and metallurgical products for silver, gold and lead by scorification and crucible methods; also the silver and base bullion assays and the assay of rich silver sulphides.

G 2. Metallurgy.

Professor Austin.

One hundred and thirty-nine hours as follows: Four recitations a week and four inspection trips to metallurgical plants on given Saturdays, including a trip to Marquette. Fall, winter and first half of spring terms. To count as eight-tenths of a credit. To be preceded by W 2 (Mineralogy), and preceded by, or accompanied with G 1 (Assaying).

This course has been arranged to emphasize the particular requirements of the mining engineer, as well as for those who are intending to specialize in metallurgy.

The instruction covers the following subjects:

(1) *Ores,* their characteristics, classification and qualities.

(2) *Sampling* of ores and products.

(3) *Preparation of Ores.* Crushing, crushing machinery, and the kinds and fineness of crushing.

(4) *Fuels,* natural and artificial, manufacture of fuels, gas producers and apparatus.

(5) *Fluxes and metallurgical reagents.*

(7) The study of bone-ash and discovery of phosphorus-oxides and hydroxides of phosphorus.

(8) The study of borax and quartz; borum and silicon.

(9) Theoretical deductions. Electrolysis. Thermo-chemistry. Structural and stereographic formulæ.

The students are required to take notes during the lectures, and they must keep a detailed account of their own observations and deductions in the laboratory. The term standing is derived from these notes and from the recitations, which are held once a week.

F 2. Blowpipe Analysis.

Professor Koenig, Dr. Koch and Mr. Wilson.

Twelve hours a week, five weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as two-tenths of a credit. The lectures are merely a continuous set of demonstrations by the professor to show how the reactions should be made.

This is a short course in Qualitative Analysis in which preference is given to reactions in the igneous way, so that students may be enabled to take the course in Mineralogy with full benefit.

Brush's tables and Landauer's small treatise are referred to.

To be preceded by F 1 (General Chemistry).

F 3. Qualitative Analysis.

Professor Koenig and Dr. Koch.

Twelve hours a week, twenty-eight weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as eleven-tenths of a credit. To be preceded by F 1 (General Experimental Chemistry) and F 2 (Blowpipe Analysis).

This course embraces the chemistry of the metals and their technically important salts. In the case of gold, for instance, the student receives 200 mgrs. of the pure metal and after having converted it into the prescribed compounds and studied the reactions, he must return the gold as pure metal. As this is time-taking the course has been extended beyond the usual limit.

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F 4. Volumetric Analysis.

Professor Koenig and Dr. Fernekes.

Twelve hours a week, for twelve weeks. To count as five-tenths of a credit. Two lectures and one recitation a week. To be preceded by F 3 (Qualitative Analysis).

The course comprises: Alkalimetry, acidemetry. Volumetric analysis of limestone and marl. Analysis of copper ores by gravimetric, volumetric, colorimetric and electrolytic methods in order that the student may learn their relative merits. Permanganate, dichromate and iodometric methods.

Sutton's Volumetric Analysis for reference.

F 5. Advanced Quantitative Analysis.

Professor Koenig.

Twelve hours a week, thirty-three weeks. One lecture, one recitation and eight hours of laboratory work a week. To count as twelve-tenths of a credit.

This course embraces: the analysis of fats, oils and soaps; the extraction and estimation of poisons; the analysis of fertilizers; the analysis of explosives; the estimation and separation of the rare elements in minerals; analysis of samarskite; nitrometry, and oxygenometry. Gas Analysis, according to Bunsen, Hempel and Winkler. Theoretical chemistry.

To be preceded by, or accompanied with F 7 (Quantitative Analysis).

F 6. Synthetic and Theoretical Chemistry.

Professor Koenig.

Eighteen hours a week, thirty-three weeks. To count as two credits. Candidates must have completed subjects F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis) and W 3 (Mineralogy).

This course is intended as an amplification of the course in

General Chemistry, to cultivate the field of original discovery and invention; to produce with known reactions a desired commercial result. The modern theories based upon the physico-chemical researches of late years are to be fully discussed and compared with former notions upon the constitution of chemical compounds. Students who wish to take this course must have shown by their previous work that they possess the required originality of mind and practical sense. To all others it is a waste of time. The students are required to read much chemical literature and to discuss their reading in a seminar to be appointed from time to time. The subjects of experimentation may either originate with the student or may be suggested by the professor.

The student must keep a minute account of all his work, in arranging the apparatus, as well as in the actual experiment, whether the latter be a failure or a success.

F 7. Quantitative Analysis.

Professor KOENIG and Dr. FERNEKES.

Twelve hours a week, twenty-one weeks; two lectures and one recitation a week. To count as nine-tenths of a credit.

Course embraces: (1) Analysis of iron ores. The sample is made up to contain all the elements likely to be of importance in iron ores. In the soluble portion are to be determined volumetrically iron, copper, manganese, phosphorus, sulphur. In the insoluble portion are determined the oxides SiO_2, TiO_2, Cr_2O_3, Fe_2O_3, CaO and MgO by gravimetric methods. (2) Analysis of Pig Iron and Steel, including colorimetric estimation of carbon and manganese. (3) Analysis of Matte and Speiss, embracing the separations of arsenic, antimony, tin, bismuth, silver, copper, cadmium, zinc and iron.

The lecture notes serve as a guide, but the student is referred to the digests of Fresenius, Classen, E. F. Smith.

To be preceded by F 4 (Volumetric Analysis).

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G. METALLURGY.

Professor Austin, Mr. Copeland and Mr. Tuttle.

G 1. Assaying.

Professor AUSTIN, Mr. COPELAND and Mr. TUTTLE.

Lectures and recitations *once a week,* sixteen weeks, winter and first half of spring terms, and one hundred twenty hours of laboratory work, including half-hour daily recitations. To count as five-tenths of a credit. To be preceded by subjects F 3 (Qualitative Analysis) and W 2 (Mineralogy).

The Fire-Assaying comprises: Assay of ores and metallurgical products for silver, gold and lead by scorification and crucible methods; also the silver and base bullion assays and the assay of rich silver sulphides.

G 2. Metallurgy.

Professor AUSTIN.

One hundred and thirty-nine hours as follows: Four recitations a week and four inspection trips to metallurgical plants on given Saturdays, including a trip to Marquette. Fall, winter and first half of spring terms. To count as eight-tenths of a credit. To be preceded by W 2 (Mineralogy), and preceded by, or accompanied with G 1 (Assaying).

This course has been arranged to emphasize the particular requirements of the mining engineer, as well as for those who are intending to specialize in metallurgy.

The instruction covers the following subjects:

(1) *Ores,* their characteristics, classification and qualities.

(2) *Sampling* of ores and products.

(3) *Preparation of Ores.* Crushing, crushing machinery, and the kinds and fineness of crushing.

(4) *Fuels,* natural and artificial, manufacture of fuels, gas producers and apparatus.

(5) *Fluxes and metallurgical reagents.*

(6) *Refractory materials,* basic, neutral and acid and their application.

(7) *Gold.* Roasting, Cyaniding, Chlorination.

(8) *Silver.* Ores and their occurrence. Roasting, Hyposulphite leaching, Russell process. Cyaniding of silver ores.

(9) *Iron.* Blast furnace production of pig iron. Ores of iron, blast furnace and accessories, blast furnace reactions, calculation of furnace charges, pig iron.

(10) *Copper* (with accompanying gold and silver). Ores of copper. Roasting, blast furnace matte smelting, pyritic smelting, reverberatory matte smelting. Smelting of oxidized copper ores to pig copper. Refining to blister copper. Copper converting. Hydrometallurgy of copper.

(11) *Lead* (with gold, silver and copper). Lead and other ores, classification and sampling of ores. Crushing, roasting, and bedding ores. Smelting ores for lead only. Blast furnace smelting with lead as collector. Calculation of charges. Furnace products and their treatment. Costs in smelting.

(12) *Zinc.* Ores of zinc. Roasting. Retorting and furnaces.

(13) *Refining* of crude metals and products of ore reduction. Refining base bullion, of matte and blister copper, of gold and silver bullion, of pig iron into steel and wrought iron.

(14) *Commercial aspects of the treatment of ores.* Prices and marketing, sampling, assaying and grading. Labor and prices. Management of labor (American, Mexican and other). Rules of works. Skilled and unskilled labor. Duties of office force. Discipline. Pay and salaries. Supplies, accounts, estimates and costs.

(15) *Estimates,* of works or plants, operations and profits. Values of ores.

G 3. Metallurgical Laboratory Practice.

Professor AUSTIN.

Nine hours a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis) and G 1 (Assaying), and preceded by, or accompanied with G 2 (Metallurgy).

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The instruction will comprise recitations and laboratory work as follows:

Amalgamation of ores of gold and silver.

Leaching methods for the extraction of gold, silver and copper.

Pyrometry.

Manufacture and properties of refractory materials.

The melting points, formation and properties of slags, mattes and speiss.

Properties of copper.

Roasting, oxidizing, chloridizing and sulphurating.

Lead refining, separation and refining of silver and gold.

Retorting of zinc ores.

G 4. Metallurgical Designing.

Professor AUSTIN.

Nine hours a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy), Q 6 (Graphic Statics) and M 11 (Mechanical Engineering II.).

The work is mostly in the drawing room with reference to books, catalogues, drawings, models and the actual machines and plants. Students are taught to take full and accurate notes and to work therefrom. They make the needed calculations and study the design and operation of furnaces, etc. They also work on the design and equipment of metallurgical plants, and make estimates of their cost.

G 5. Metallurgical Organization.

Professor AUSTIN.

Nine hours a week, twelve weeks, fall term. To count as three-tenths of a credit. To be preceded by, or accompanied with, G 2 (Metallurgy).

The course of instruction will consist of lectures on the principles of organization and on the duties of the officers and accounting force of a metallurgical establishment.

The subject is divided as follows:

Organization of companies and of working forces. Management, superintendence, skilled and unskilled labor. Constitution of capital; stocks, bonds, dividends and profits.

It contains a Blake crusher, a Comet crusher, a pair of crushing rolls, a three stamp battery, a set (three) of trommels, two Hartz jigs, a Spitzkasten, a Frue Vanner, a Rittinger table, a Standard concentrator, a Calumet classifier, a Bridgman and a Vezin sampler, and a sample grinder, together with minor machinery.

M. MECHANICAL ENGINEERING.

Professor Hood, Messrs. Christensen, DeLay, McGrath, Johnson, Richards, Sumner and Furbeck.

The successful and economical operation of any mine depends so largely upon the judicious selection, proper design and skilful operation of the power plant and general machinery, that the College offers a course in mechanical engineering specially designed to prepare the student to take up such work.

The aim has been to so use those Mechanical Engineering subjects of special prominence in mining work as to give the student thorough training, and to indicate the methods of study and observation to be followed after graduation, should he decide to take up any branch of Mechanical Engineering as his specialty.

Throughout the whole course the attempt is made to present clearly the theory underlying each part of the work, and to fix and illustrate the theory by practical exercises in the shop, laboratory, draughting room, or reference to neighboring mine equipments.

Mechanical Engineering Building.

The workshops, mechanical laboratories, electrical engineering laboratories, and the draughting room, are located in the Mechanical Engineering Building.

Courses in the following subjects are offered:

M 1. Properties of Materials of Engineering.

Mr. Christensen.

General mechanical properties of metals; cast and wrought iron, steel, copper, brass and bronzes; lime, cement, concrete and brick; paints; timber and cordage; etc.

Three times a week, twenty-three weeks, fall and winter terms.

To count as seven-tenths of a credit. To be preceded by B 1 (Physics) and F 1 (General Chemistry), and preceded by, or accompanied with B 4 (Physics).

The course includes a discussion of methods of manufacture of the more important materials (except such information as comes within the province of the course in Metallurgy); forms in which these materials appear in the market; their adaptation to the purposes of the engineer; methods of preserving materials from corrosion and decay; etc. Johnson's The Materials of Construction. The course is supplemented with practical work in testing, for details of which see M 6 (Testing Materials of Engineering).

M 2. Shop Practice.

Mr. McGrath, Mr. Johnson and Mr. Richards.

Shop practice is of value in giving intimate knowledge of the properties of materials, of the uses of machines for working them, and of the difficulties of attaining accuracy. Judgment in the use and selection of machinery is best trained in the shop. The skill acquired in the use of machines and tools may be of direct value and is always of indirect value in giving familiarity and sympathy with such work. The course covers nine hours a day, except Saturday, for twelve weeks, summer term, and includes practice in wood and metal work. To count as two credits.

The practical instruction given is largely personal and each is advanced as rapidly as his proficiency will warrant. Recitations concerning the work are required. In the machine shop, practice is offered in bench and vise work, blacksmithing and with all of the usual machine tools. In the pattern shop, patterns are made of parts to be later completed in the machine shop. The course includes the use of wood-working bench tools and power machinery.

The shop is run as nearly like a producing shop as possible. Exercises for students are selected from parts of machines in course of actual construction and intended for use about the institution, as, crushing rolls, air compressors, rock drills, machine tools, etc. All work done in the shops is considered as the property of the college. No student is allowed work not assigned to him by the instructor.

Shop Equipment.

In addition to necessary work benches and hand tools, the shop contains—

One 24-inch by 16-foot New Haven Tool Co.'s lathe.
One 16-inch by 6-foot Lodge & Shipley lathe.
Two 14-inch by 5-foot Lodge & Shipley lathes.
Six 14-inch by 6-foot Reed lathes.
One 14-inch by 8-foot Reed lathe.
One 14-inch by 6-foot Lodge & Davis lathe.
One 13-inch by 5-foot Putnam lathe.
One 12-inch by 5-foot Prentis lathe.
One No. 2 Landis Grinder for hardened steel work.
One 24x24x8' Whitcomb planer.
One 20x20x4' Wm. Sellers & Co. planer.
One 16" Gould & Eberhardt shaper.
One 10" Traverse head shaper.
One 34" Blaisdel drill press.
One 20" Lodge & Davis drill press.
One sensitive drill.
One twist drill grinder.
One No. 1½ Cincinnati tool room milling machine.
Three emery tool grinders.
One buffing wheel.
One Power hack saw.
One 2-inch pipe and bolt machine.
One Arbor press.
One steam hammer.

The assortment of chucks, taps, drills, reamers and general tools is extensive. For practice in pipe fitting a separate bench has been provided; a complete set of pipe tools, and a supply of pipe and fittings up to two inches inclusive are in stock.

The blacksmith shop occupies a room 26x43 and is completely equipped with eight forges and the necessary hand and power tools.

The pattern shop contains ten wood lathes, a pattern maker's lathe to swing five feet, a 33-inch Fay band saw, a Beach jig saw, a 24-inch Fay hand planer and joiner, a 24-inch pony planer, Colburn universal saw bench, emery wheels and grindstones, gouge grinder, steam glue heaters, an extensive assortment of hand tools and appliances, and the necessary work benches and vises.

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Each student, in each shop, has a separate work bench, set of hand tools, and locker, for which he is held responsible. Any damage to tools, or other part of the equipment, beyond wear and tear by legitimate use, is charged to the student accountable for it.

Each shop has a good tool room, in which the check system of accounting for tools is used.

Power for the shops is furnished by an 8x24 Reynolds Corliss engine.

Special Students.

Those who desire to take shop work only, and devote all their time to it, are admitted as special students on the following conditions: No student shall be less than 17 years of age. Students between the age of 17 and 20 must present evidence of having spent at least two years in some reputable high school or academy. Persons 20 years of age or over may be admitted as special students, without having attended a high school, provided they give evidence of being able to follow the work with profit. Some knowledge of drawing, or practice in reading drawings, is essential.

Under some conditions the machine shop is open to students at other times than during the summer term.

M 3. Design of Structural Joints.

Mr. Christensen.

Fifteen hours a week, eleven weeks, winter term. To count as six-tenths of a credit. To be preceded by, or accompanied with, M 4 (Mechanics of Materials). A study of the design of structural joints in wood and metal based upon the fundamental principles of stress and strength of materials. Dimensioned sketches or drawings showing complete working details will be required in the solution of each problem.

M 4. Mechanics of Materials.

Mr. Christensen.

Three times a week, twenty-three weeks, fall and winter terms. To count as seven-tenths of a credit. To be preceded by M 1 (Properties of Materials), and preceded by, or accompanied with C 2 (Analytic Mechanics).

Application of the principles of statics to rigid bodies; elasticity and resistance of materials; cantilevers; simple, restrained and continuous beams; forms of uniform strength, riveting, torsion of shafts, combined stresses; resiliance; apparent and true stresses; computation of proper sizes and proportions of beams, columns, shafts, flat plates, etc. Merriman's Mechanics of Materials, and Cambria Steel.

M 5. Mechanical Engineering I.

Professor Hood.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit. A non-mathematical treatment of the steam engine, boiler, and attendant details, being an introduction to the Mechanical Engineering of Power Plants. Text book, Hutton's The Mechanical Engineering of Power Plants.

M 6. Testing Materials of Engineering.

Professor Hood and Mr. Christensen.

Tensile, compressive, transverse and torsional tests of metals and timber. Tensile tests of cordage, and iron and steel wire rope. Transverse, compressive, and absorption tests of stone and brick. Tensile, comprehensive, cross-breaking, and specific gravity tests of cement, also tests for fineness, time of setting, and constancy of volume. Tests of lubricating oils, including density, viscosity, fire test, cold test, wearing qualities and co-efficient of friction under various speeds and loads on journals. *Forty-five hours a week,* last six weeks of summer term. To count as one credit. To be preceded by subject M 4 (Mechanics of Materials). Text books used, Johnson's Materials of Construction and Spalding's Hydraulic Cement.

Laboratory for Testing Materials.—The equipment of this laboratory is as follows: One 100,000 ℔. Riehle machine, fitted for making tensile, compressive, cross breaking, and shearing tests. Special appliances have also been provided to enable this machine to make shearing tests on wood, and transverse tests on specimens up to 9 feet in length; an Olsen No. 1 power torsional testing machine, a Thurston autographic torsional testing machine, an Ashcroft oil tester, 2,000 lb. Olsen cement testing machine, with tools

for tensile, compressive and transverse tests, briquette forming and cement mixing machines, and other measuring and testing devices.

. Those having materials to be tested may make arrangements with the professor in charge of the department for tests.

M 9. Mechanical Engineering: Laboratory Practice.

Professor Hood and Mr. Christensen.

Experimental work in the Mechanical Laboratory; determination of heating value of fuels; quality of steam; use of steam engine indicator; Prony brake, and other dynamometers; standardizing of indicators, steam gauges, etc.; valve setting, complete tests of engines, boilers and pumps, Carpenter's Experimental Engineering, Kent's Mechanical Engineer's Pocket Book. *Forty-five hours a week,* first six weeks of summer term. To count as one credit. Must be preceded by M 13 (Mechanical Engineering IV.). This course is intended to give the student ample opportunity to verify practically the principles laid down in the preceding courses. Each student will be required to set up his own apparatus, and in many cases to design and build appliances for any special work on hand.

Equipment.

The power plant contains two Parker Steam Generators of 100 H. P. each, one 58 H. P. Stirling water-tube boiler, induced draft system, one 8x24 Reynolds Corliss engine, one 8x12 Buckeye engine in the dynamo room, a 9x9 N. Y. safety vertical slide valve engine in the Ore Dressing building, a 5x5 horizontal slide valve engine, and one 50 H. P. Wheeler surface condenser, with Worthington air and circulating pump. Of the minor apparatus there is now in stock one Tabor indicator, and six Crosby indicators with electrical attachment, one Hine & Robertson indicator, one Collins continuous indicator, eight polar planimeters, ten of Green's standard thermometers for calorimetric work, calorimeters of the following kinds—barrel, continuous, superheating, throttling, and separator; Carpenter Coal Calorimeter, and Parr Calorimeter—one 15 H. P. Flather hydraulic dynamometer arranged for either transmission or absorption, Heath's stop-watch speed counter. Tabor speed counter, Schaeffer & Buden-

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pansion, its flow through pipes, and also of the various types of air compressing and actuating machinery. Lectures, Kent's Mechanical Engineer's Pocket Book and Compressed Air and its Applications, Hiscox.

M 15. Mechanical Drawing.

Messrs. DeLay, Sumner and Furbeck.

Fifteen hours a week, twelve weeks, fall term. To count as six-tenths of a credit.

The use of drawing instruments, the graphical solution of geometrical problems. Descriptive Geometry. Projection on right and oblique planes, intersections of lines, surfaces and solids, plans, elevations and sections, isometric projection. Anthony's Elements of Mechanical Drawing. Reinhardt's Lettering.

The instruction in the art of drawing is designed to give prominence to such branches of the subject as are of most value to the practicing engineer. It is required that the instruments used shall be of the best and for the convenience of students a suitable grade is offered for sale at the College. Instruments required are:

One $5\frac{1}{2}$-inch compass.
One $3\frac{1}{4}$-inch bow spacer.
One $3\frac{1}{4}$-inch bow pencil.
One $3\frac{1}{4}$-inch bow pen.
One 5-inch ruling pen.
One 30°—60° triangle.
One 45° triangle.
One curve.
One 30-inch Tee square.
Two bottles of ink.
Eight thumb tacks.
Three rubbers.
Two pencils.
Twelve pens.
One penholder.
wipers.

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M-6. Machine Drawing

N. ELECTRICAL ENGINEERING

gives some familiarity with current engineering practice. Such subjects as are of special prominence in mining are naturally accentuated here. The courses outlined are as follows:

N 1. Electrical Engineering.

Mr. DeLay.

An introductory course presenting dynamo and motor construction, transformers, secondary batteries, lamps, etc., and questions concerning their selection, installation, care and wiring for light and power. Electrical Engineering by Rosenberg, Gee and Kinzbrunner, and Badt's Incandescent Wiring Hand-Book. *Three times a week,* twenty-three weeks, fall and winter terms. To count as seven-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and preceded by, or accompanied with, B 3 (Electrical Measurements).

N 3. Electrical Engineering: Laboratory Practice.

Professor Hood and Mr. DeLay.

Experimental work in the Electrical Laboratory, having for its object the familiarizing of the student with the general construction, running and testing of the common forms of electrical apparatus used in lighting and power transmission. The laboratory affords practice with direct, alternating and polyphase currents, incandescent and arc lighting, and motors on constant potential, constant current and polyphase circuits.

The equipment includes two direct current dynamos with four motors. A 33 K. W., 1,000 Volt, alternating current machine. A 15 K. W. three phase generator with three motors. Two arc light machines, one constant current motor, a 60 Cell Storage Battery, all with suitable switch board, instruments, transformers and laboratory measuring instruments.

Forty-five hours a week, second six weeks of summer term. To count as one credit. To be preceded by N 1 (Electrical Engineering).

[redacted]

Q. CIVIL ENGINEERING.

Professor Sperr, and Messrs. Shoemaker, Hoyt, Graham, Brooks and Schubert.

Q 1. Surveying (Field Work).

Professor SPERR, and Messrs. HOYT, JORDAN, GRAHAM and SCHUBERT.

Fifty hours a week, twelve weeks, summer term. Beginning about the first of June each year. To count as two and two-tenths credits. To be preceded by A 3 (Spherical Trigonometry) and Q 4 (Topographical Drawing), except that persons of experience, who wish to attend this course only, are required to prepare themselves upon the subjects of Plane Trigonometry, Logarithms and Mensuration; and provide themselves with the drawing instruments and materials required for Drawing under the Civil Engineering department. All persons who desire to attend are requested to send in their names early to Professor Sperr, or to the President of the College, in order that proper provision may be made for them.

It is believed that the principles of surveying can be more easily and more thoroughly learned if the study of the text book and the use of the instruments go hand in hand. The lessons in the text books are assigned ahead of the time when the work is taken up in the field, in order that the student may first study the subject and then work out the problems which arise from his own use of the instruments in the field.

The aim in laying out the field work is to make it of a commercial character, to be executed in a commercial and practical manner.

An outline of the work is as follows:

I. Preliminary Surveying.

1. Pacing practice.
2. Preliminary location of mining claims and filing of notice of location.
3. Adjustment of hand level. Short line of levels with the hand level.

4. Topographical survey of mining claim by pacing and hand level.
5. Ranging practice with pickets and chain.

II. Land Surveying.

1. Adjustment of compass.
2. Subdivision of a section of land according to United States Land Office regulations, location of lost corners, etc.
3. Farm survey with transit and chain. Computation of acreage.
4. City survey of portion of Houghton, location of street, alley, and lot lines by transit and steel tape. Platting an addition.
5. Survey of mining claim with solar instrument, official survey for United States patent. Includes adjustment of solar attachments.

III. Geodetic Surveying.

1. Measurement of base line for triangulation system covering an area of about ten square miles on the opposite shores of Portage Lake. Standardizing tapes.
2. Erection of signals and stations for triangulation observation.
3. Reading angles with the transit.
4. Computations for and adjustment of the triangulation system.
5. Adjustment of Engineers' level.
6. Determination of elevations of bench marks and triangulation points by leveling from Portage Lake.
7. Observation on Polaris with transit for determination of true azimuth.

IV. Topographical Surveying.

1. Adjustment of transit.
2. Repetition traverse with transit and steel tape.
3. Azimuth traverse with transit and stadia.
4. Adjustment of plane table instrument.
5. Topographical survey of certain area with plane table.
6. Topographical survey of certain area with transit and stadia.
7. Tying up of topographical survey to triangulation system.

V. Railroad Surveying.

1. Reconnoissance [illegible].
2. Preliminary [illegible]. Topography by [illegible].
3. Permanent [illegible] level.
4. Computation of simple and [illegible] and line stakes [illegible].
5. Profile leveling. [illegible] of grade.
6. Cross-sectioning.
7. Computation of [illegible].
8. Computing and laying [illegible] junction curves.

Maps are required [illegible] the mining claim [illegible] surveys, the farm survey, [illegible] railroad survey.

The class is [illegible] in the squad to do the required work. [illegible] the class is required [illegible] different instrument [illegible] by his squad, and from these [illegible] room.

The equipment for [illegible] instruments:

Five Buff & Berger [illegible].
Four C. L. Berger & Sons [illegible].
Three Heller & Brightly [illegible].
Two Fauth & Co. [illegible].
Five W. & L. E. Gurley [illegible].
One Mahn & Co. [illegible].
Eight W. & L. E. Gurley Engineer's levels.
Three Heller & Brightly Engineer's levels.
One Buff & Berger Engineer's levels.
Two C. L. Berger & Sons Engineer's levels.
One Buff & Berger plane table.
One C. L. Berger & Sons plane table.

Two W. & L. E. Gurley plane tables.
Five W. & L. E. Gurley Burt solar compasses.
Seven W. & L. E. Gurley Surveyor's compasses.
Five Brunton pocket mine transits.
Ten water levels.
Forty-eight Locke hand levels.

In addition to these more expensive instruments the College owns the necessary number of chains, steel tapes, poles, rods, etc.

The furnishing of the Surveying apparatus by the College is a heavy expense to the institution, and while losses due to ordinary and legitimate wear and tear of the instruments are borne by the College, any injuries due to carelessness on the part of the student must be made good by him.

Every student is required to provide himself with a steel pocket tape graduated to feet and tenths, and not less than 25 feet long, a pocket compass, a reading lens, a wood ax, a timber pencil, a field book, and drawing instruments as in Q 4 (Topographical Drawing).

Text Books: Theory and Practice of Surveying, Johnson; Field Engineering, Searle.

Q 2. Hydraulics.

Mr. Hoyt.

Three times a week, sixteen weeks, winter and first half of spring term. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining), and preceded by, or accompanied with, A 5 (Calculus).

Recitations and problems on the following:

1. Hydrostatics.
2. Theoretical hydraulics.
3. Flow through orifices.
4. Flow over weirs.
5. Flow through tubes.
6. Flow in pipes.
7. Flow in conduits and canals.
8. Flow in rivers.
9. Measurement of water power.

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10. Dynamic pressure of flowing water.
11. Water wheels.
12. Turbines.

Text Book: Treatise on Hydraulics, Merriman.

Q 3. Hydraulics.

Professor SPERR and Mr. SHOEMAKER.

Two hours a week in lecture room and *seven hours* in laboratory, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by Q 2 (Hydraulics) and M 5 (Mechanical Engineering I.).

The Hydraulic Laboratory is provided with two main reservoirs, —a steel supply reservoir of 18,000 gallons capacity in the tower of the building, and a reservoir below in the form of a canal of 25,000 gallons capacity, giving a head of about 90 feet. The discharge from the supply reservoir is through a 10-inch stand pipe, which may be drawn from at the different floors in the tower by nine 10-inch Fairbanks gate valves. Galvanized iron conduits pass the entire length of the tower and are so arranged as to conduct the flow into the reservoir below or into large weighing tanks at will.

The main part of the laboratory is sixteen feet in the clear, with balcony around for accommodation of light appliances. Also passing around this part are mains as follows: A 6-inch water supply, a 6-inch pump discharge (into supply reservoir or weighing tanks), a 2½-inch steam supply, a 3-inch steam exhaust (into atmosphere or surface condenser), and along the north balcony, a 6 x 12-inch conduit to a pair of hanging tank scales. Steam and electricity are furnished by the central Power Plant operated by the Mechanical Department.

A complete electrical signal and telephone system is in operation, consisting of fixed and portable sets so arranged that communication may be had between any two or more points in the Main Laboratory or Tower.

The following apparatus is now available for experimental work:

One 5½ x 3½ x 5 Snow duplex steam pump.

One 8 x 8½ x 12 Snow duplex steam pump.

One 6 x 12 Deane triplex electric pump with 7 H. P. induction motor and Reeves speed regulator.

One 12-inch Morris centrifugal pump.

One Evans hydraulic gravel elevator, with sluices, undercurrent and riffles.

One Evans hydraulic giant.

One 20-inch Pelton water motor.

One 15-inch Tuthill water motor.

One 8-inch Leffel turbine.

One Worthington water meter.

One Price acoustic current meter.

One orifice tank for low heads.

Two Buffalo platform tank scales, each 20,000 lbs. capacity.

Two Buffalo hanging tank scales, each 3,560 lbs. capacity.

Two Buffalo platform scales, each 2,560 lbs. capacity.

One Buffalo laboratory scales of 400 lbs. capacity, and sensitive to 1/100 of a pound.

One 5 H. P. electric induction motor for driving line shaft.

Six valve orifice plates of special design, with orifices interchangeable from the outside and without loss of water.

In the laboratory are also numerous orifices and weirs of various shapes and sizes, steam, water, mercury, and hook guages; speed indicators, steam indicators, and other apparatus necessary for determining the efficiency and coefficients of the various hydraulic appliances used in connection with mining operations.

Text Books:

Treatise on Hydraulics, Merriman.
Notes and Library References.

Q 4. Topographical Drawing.

Messrs. SHOEMAKER, HOYT, GRAHAM and BROOKS.

Fifteen hours a week, five weeks, last five weeks of spring term. To count as three-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). This subject is required for the summer course in Surveying (Q 1). The course is given by lectures and individual instruction in the Drawing Room on the following.

I. Making Titles, Scales, Borders, etc.
II. Traversing.

III. Plotting.
   1. By Protraction.
   2. By Rectangular Co-ordinates.

IV. Computing.
   1. Areas.
   2. Volumes.

V. Topography.
   1. Topographical Signs.
   2. Topographical Maps.

Instruments Required.

One 5-inch right line pen.
One swivel curve pen.
One 5½-inch compass (pivot joint) with hair spring, pen, pencil, points and extension bar.
One 3¼-inch bow pen.
One 3¼-inch bow pencil.
One 3¼-inch bow dividers.
One protractor.
One 12-inch triangular decimal scale.
One 10-inch 30 x 60-degree amber triangle.
One 9-inch 45-degree amber triangle.
One-half dozen thumb tacks.
One bottle Higgins' black *water-proof* drawing ink.
One bottle Higgins' carmine drawing ink.
One rubber pencil eraser.
One ink eraser.
One sponge rubber.
One 6H pencil.
One piece chamois skin, about 12 x 8 inches.
One-half pan each, moist colors, as follows: Prussian blue, burnt sienna.
Two No. 1 Spencerian pens, with holder.
Two mapping or crow quill pens, with holder.
Two ball pointed pens.

All instruments must be of first-class quality. Students will not be allowed to work with inferior instruments. Articles in the above list may be purchased by students at the College.

Text Books:

A System of Free-hand Lettering, Reinhardt.
The Theory and Practice of Lettering, Sherman.
Theory and Practice of Surveying, Johnson.

Q 5. Surveying (Office Work).

Messrs. SHOEMAKER and HOYT.

Nine hours a week for twelve weeks, fall term. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying).

In this course the objects and purposes of the field and railroad surveying are more fully developed,—new points are taken up in the text by lecture and recitation, and practice is given in the drawing room involving methods and instruments used in the surveyor's office.

Text Books:

Notes and Library References.
The Theory and Practice of Surveying, Johnson.

Q 6. Graphical Statics.

Messrs. SHOEMAKER, HOYT, GRAHAM and BROOKS.

Twelve hours a week (one lecture, two recitations and nine hours in drawing room), twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics).

This subject is designed to teach the theory of the graphical analysis of stresses in structures, under the action of steady and moving loads, and the pressure of the wind. For example, the solution of a certain class of roof trusses is taken up in the lecture. The student is assigned a number of problems on the different types of trusses in this class, to be solved in the drawing room by aid of the text book and such individual instruction as may be necessary. For this problem he would be required to report the nature and value of the stress in each member of the truss under the various loads specified, each student being given different conditions and data.

Text Book:

Graphical Analysis of Roof Trusses, Greene.

Q 7. Engineering Design and Construction.

Professor Sperr and Mr. Hoyt.

Twelve hours a week, sixteen weeks, winter and first half of spring terms. To count as seven-tenths of a credit. To be preceded by Q 6 (Graphical Statics), and preceded by, or accompanied with R 4 (Mining Engineering), and M 4 (Mechanics of Materials).

The work in designing is applied to the head-frames, rock houses, engine and boiler houses, bridges, trestles, etc., of the mining plants considered under R 4 (Mining Engineering).

A general outline of the work is as follows:

1. The general requirement of the structure.
2. Drawing the general plans.
3. The materials best adapted to the various purposes.
4. Strength of materials.
5. Methods of construction.
6. Making detailed drawings, bills of materials, and estimate of costs.
7. Synopsis of the law of contracts.
8. Drawing up specifications.
9. Letting contracts.
10. Superintending the construction.

R. MINING ENGINEERING.

Professor Sperr, and Messrs. Shoemaker, Hoyt, Graham, Brooks and Schubert.

Mining engineering as here used, signifies carrying through a mining enterprise. Intelligently conducted mining operations employ the principles of mathematics, physics and mechanics; the sciences of geology, mineralogy, chemistry and metallurgy; and the arts of civil, mechanical and electrical engineering; and demand capacity for organization and business management.

These principles, sciences, etc., are taught by specialists and experts in different departments; and their special application to the

Text Books:

A System of Free-hand Lettering, Reinhardt.
The Theory and Practice of Lettering, Sherman.
Theory and Practice of Surveying, Johnson.

Q 5. Surveying (Office Work).

Messrs. SHOEMAKER and HOYT.

Nine hours a week for twelve weeks, fall term. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying).

In this course the objects and purposes of the field and railroad surveying are more fully developed,—new points are taken up in the text by lecture and recitation, and practice is given in the drawing room involving methods and instruments used in the surveyor's office.

Text Books:

Notes and Library References.
The Theory and Practice of Surveying, Johnson.

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Messrs. SHOEMAKER, HOYT, GRAHAM and BROOKS.

Twelve hours a week (one lecture, two recitations and nine hours in drawing room), twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics).

This subject is designed to teach the theory of the graphical analysis of stresses in structures, under the action of steady and moving loads, and the pressure of the wind. For example, the solution of a certain class of roof trusses is taken up in the lecture. The student is assigned a number of problems on the different types of trusses in this class, to be solved in the drawing room by aid of the text book and such individual instruction as may be necessary. For this problem he would be required to report the nature and value of the stress in each member of the truss under the various loads specified, each student being given different conditions and data.

Text Book:

Graphical Analysis of Roof Trusses, Greene.

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Q 7. Engineering Design and Construction.

Professor Sperr and Mr. [illegible]

Twelve hours a week, sixteen weeks, winter and first half of spring terms. To count as seven-tenths of a credit. To be preceded by Q 6 (Graphical Statics), and preceded by, or accompanied with R 4 (Mining Engineering), and M 4 (Mechanics of Materials).

The work in designing is applied to the head-frames, rock houses, engine and boiler houses, bridges, trestles, etc., of the mining plants considered under R 4 (Mining Engineering).

A general outline of the work is as follows:

1. The general requirements of the structure.
2. Drawing the general plans.
3. The materials best adapted to the various purposes.
4. Strength of materials.
5. Methods of construction.
6. Making detailed drawings, bills of materials and estimates of costs.
7. Synopsis of the law of contracts.
8. Drawing up specifications.
9. Letting contracts.
10. Superintending the construction.

R. MINING ENGINEERING.

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Mining engineering as here used, signifies carrying through a mining enterprise. Intelligently conducted mining operations employ the principles of mathematics, physics and mechanics; the sciences of geology, mineralogy, chemistry and metallurgy; and the arts of civil, mechanical and electrical engineering; and demand capacity for organization and business management.

These principles, sciences, etc., are taught by specialists and experts in different departments; and their special application to the

II. MINING.

1. Coal Mining.
   a. Prospecting the Property.
   b. Locating the Shaft, Slope or Drift.
   c. Laying out the Mine.
2. Iron Ore Mining.
   a. Prospecting the Deposit.
   b. Locating the Shaft.
   c. Laying out the Mine.
3. Mine Timbering.
   a. Drifts and Levels.
   b. Stopes.
   c. Raises and Chutes.

The instruction is given from private notes and from references to professional papers to be found in the College library.

R 3. Mine Surveying and Mining (Field Work).

Professor SPERR and Messrs. HOYT, GRAHAM, BROOKS and SCHUBERT.

Fifty-four hours a week, five weeks, last half of spring term. To count as one credit. To be preceded by R 2 (Mine Surveying and Mining), except for students who enter for this subject only, who are required to be prepared in Algebra, Trigonometry, and in the use of the transit and level.

The first two weeks are devoted to surveying and mapping a mine or some portion thereof, in some one of the iron mining districts of Northern Michigan. The last three weeks are devoted to the examination of mining methods in the iron ore mines. Sketches are made of the plans of the mines to show methods of laying out; of cross-sections to show methods of stoping; of timber structures to show methods of framing; of the timbering set up in drifts and stopes; of the tramming, hoisting and general handling arrangements; of ore chutes, ore pockets, etc.

R 4. Mining Engineering.

Professor SPERR.

Three times a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by C 2 (Analytic Mechanics), M 4 (Mechanics of Materials), R 3 *(Mine Surveying* and Mining) and Q 2 (Hydraulics).

The subject is divided as follows:

1. The examination and description of mining properties—expert reports, estimates and recommendations.
2. Laying out and planning the surface arrangements for mining operations—head frames, power plants, ore dressing works, houses, roads, and hydraulic engineering works.
3. Laying out mining operations—winning by open pit, adit, slope, shaft and drill hole; and the exploitation of quarries, placers, and deposits of ore, coal, and mineral fluids.
4. Experimental work with mining machinery in the laboratory.

R 5. Mine Management and Accounts.

Professor Sperr.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining) and R 3 (Mine Surveying and Mining).

The subject comprises the following:

1. Employment, organization and discipline of labor.
2. Purchase and use of supplies.
3. Preparation and sale of mineral.
4. Mine accounts, trial balances, and cost and labor statements.

Given by lectures and a set of notes covering the daily transactions for one month of an extensive mining business.

The proper forms of accounts are designed, ruled up, and the transactions entered thereon. Then the books are closed and the trial balance, production, labor and cost statements are made out.

R 6. Mechanical Ventilation of Mines.

Professor Sperr.

Two hours a week in lecture room and *seven hours* in laboratory, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The laboratory affords facilities for experimental work with mechanical and hot air ventilators and with various other means for the production of air currents in mines. The ventilating system of the building was put in with this object in view, and it makes

a valuable addition to the equipment. A wide field for investigation and research in the laws of ventilation is here presented for advanced students.

The subject is required to be preceded by, or accompanied with, Q 2 (Hydraulics), R 4 (Mining Engineering) and preceded by M 5 (Mechanical Engineering I.).

V. BIOLOGY.

Professor Seaman and Mr. Hancock.

V 2. Palaeontology.

Twelve hours a week, twelve weeks, fall term. To count as five-tenths of a credit.

An elementary course only is given in this subject. The object of the course is to train the student in the recognition and determination of a few of the typical fossils from each geological period.

This course must precede Y 2 (Historical Geology).

An elementary knowledge of Zoology will be required of students taking this subject.

The laboratory is supplied with a good collection for students' use.

W. MINERALOGY.

Professor Seaman, and Messrs. Corey, Bowen and Hancock.

W 1. Crystallography.

Professor SEAMAN, and Messrs. HANCOCK and BOWEN.

Nine hours a week twelve weeks, fall term. To count as four-tenths of a credit.

The instruction is given by means of lecture notes, and laboratory work, study of models, natural crystals, and cleavage fragments. Hemihedrism, tetartohedrism, hemimorphism and twinning are fully explained in this course.

The laboratory is well supplied with models and natural crys-

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tals, necessary for teaching this subject. To be preceded by W 4 (Elementary Mineralogy and Crystallography).

Elements of Crystallography, By G. H. Williams, is used as a text book in this subject.

W 2. Mineralogy.

Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

Twelve hours a week, sixteen weeks, winter and first half of spring terms. To count as seven-tenths of a credit.

Students taking this course are required to provide themselves with A System of Mineralogy, by J. D. Dana, and lecture notes by Professor Seaman.

Individual work is one of the features of this course. Each student is required to work out an assigned lot of minerals, and personally recite to an instructor. In these recitations he is required to point out the particular physical characters by which he recognizes his minerals. He must be able to give the chemical composition, orientate the crystal form, and cleavage, and describe the other physical properties that exist. Each student in this course must become familiar with more than two hundred mineral species so that he can either recognize them at sight, or at least after he has applied a few simple field tests, such as hardness, fracture, cleavage, etc.

This subject must be preceded by B 1 (Physics), F 2 (Blowpipe Analysis), W 1 (Crystallography), and Y 1 (Principles of Geology).

W 3. Advanced Mineralogy.

Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

Six hours a week, twenty-three weeks, fall and winter terms. To count as five-tenths of a credit.

This course will be offered only to students who are specializing in Geology, and are taking the advanced Petrography (X 2).

Some of the rare minerals will be studied, as well as some of the less important ores. The products of alteration will be studied more in detail than in the preceding courses. Thermo-electricity, radio-activity and other physical characters not treated in the regu-

lar course, will be discussed and exemplified. About one hundred mineral species not given in the other courses will be studied in some detail.

To be preceded by W 2 (Mineralogy).

W 4. Elementary Mineralogy.

Professor SEAMAN and Messrs. COREY, BOWEN and HANCOCK.

Fourteen hours a week, twelve weeks, fall term, and *three hours a week,* sixteen weeks, winter and first half of spring terms. To count as eight-tenths of a credit.

The first four weeks of the fall term will be devoted to crystal study. The last eight weeks will then be given to the study of ore-forming and rock-forming minerals. Only the more common important minerals will be studied in this course. Each student will be required to become familiar with at least fifty mineral species.

In the winter and spring terms the students will be instructed in the classification and determination of rocks, the object of the course being to give the student a sufficient knowledge of rocks and minerals to enable him to comprehend his work in Principles of Geology.

X. PETROGRAPHY.

Mr. Corey and Mr. Bowen.

X 1. Petrography.

Nine hours a week, twenty-eight weeks, fall, winter, and first half of spring terms. To count as eight-tenths of a credit. To be preceded by Y 1 (Principles of Geology), and preceded by, or accompanied with B 5 (Light) and W 4 (Elementary Mineralogy and Crystallography).

The work is divided into two parts: Microscopic Mineralogy and Lithology.

A. Microscopic Mineralogy: Under this head are treated the optical and physical characters of minerals, as revealed by the microscope. Especial attention is directed to those characters by which the minerals may be recognized as rock constituents. The alterations of the minerals are studied with care, owing to the importance of these in the subject of Economic Geology.

B. Lithology: The instruction in this branch of Petrography

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comprises both the macroscopic and microscopic study of rocks. For this work large and complete collections of rock specimens with thin sections are arranged for the use of the student. The lectures are illustrated by typical hand specimens; also by thin sections projected on a screen by means of a large projecting microscope. Special attention is called to the variations in rocks and to their local modifications due to their special mode of occurrence in the field.

The course is made thorough and practical, every student receiving personal instruction and being required to recite on a large number of hand specimens, and write accurate petrographic descriptions of specimens from various localities.

X 2. Advanced Petrography.

Messrs. Corey and Bowen.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

This course will consist of a detailed study of the rocks of some assigned locality. Each student is required to make a complete and thorough petrographic report on a group of rocks. Determinations are made of physical, optical and crystallographic constants of rock-making minerals. The relations of the alterations of rocks to ore deposition are taken up more fully than in the course X 1 (Petrography). To be preceded by X 1 (Petrography), and preceded by, or accompanied with W 3 (Mineralogy).

Y. GEOLOGY.

Professor Seaman, and Messrs. Corey, Bowen and Hancock.

Y 1. Principles of Geology.

Professor SEAMAN and Mr. COREY.

Two times a week, twelve weeks, fall term, *one time a week,* sixteen weeks, winter and first half of spring terms. To count as four-tenths of a credit. An elementary text-book will be used in this course. Either Elements of Geology, by Le Conte, or An Introduction to Geology, by W. B. Scott. No student will be given credit in this course until he has completed W 4 (Elementary Mineralogy and Crystallography).

Y 2. Historical Geology.

Professor SEAMAN and Mr. HANCOCK.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in this study will consist of recitations and laboratory work, and will be given following V 2. The main object of the course will be to familiarize the student with the life history of the earth, and with the lithological character, order of superposition, periods of upheavel, and the areal distribution of the formations which compose the earth's crust.

There will be laboratory drill in assigning fossils to their proper geological period. In this work the students will have access to palæontological literature, with which the library is well supplied, and will be required to prepare palæontological charts to facilitate their work. The material at present accessible for the laboratory work consists of a palæontological collection of about eight thousand specimens, three small rock collections, one Europeon and two American, containing six hundred specimens, arranged stratigraphically, and over one thousand specimens of sedimentary rocks representing the geological column.

In addition to the above, some time will be given to surface geology, in which the present contours of the earth's surface will be discussed.

The text book used is An Introduction to Geology, by W. B. Scott, supplemented by the use of the correlation papers of the U. S. Geological Survey. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology).

Y 3. Physical and Chemical Geology.

Professor SEAMAN and Mr. COREY.

Three times a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in Physical Geology is intended to be especially adapted to the needs of the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman, and all others

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who desire to understand the connection and the structural relations that rock masses have to one another and to the valuable deposits which they may contain. It treats of the origin and alterations of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, cleavage, mountain building, eruptive rocks and crystalline schists; the action of air, surface and underground waters, and life; the interior condition of the earth, etc., especially in their relations to the problems that the economic geologist, miner and quarryman have to meet. The student has brought before him constantly the various problems that arise in practical work and the methods of their solution.

This course enlarges and completes much that is briefly touched upon in the Principles of Geology and in Petrography.

The text book used is Dr. Archibald Geikie's Text Book of Geology, fourth edition, 1903, books I, II, III, IV and VII.

Students who take this subject must have completed W 2 (Mineralogy), and X 1 (Petrography) must precede or accompany this subject.

Y 4. Geological Field Work.

Professor Seaman and Messrs. Corey and Bowen.

Forty-five hours a week for the last six weeks of the summer term. To count as one credit. The instruction in this subject begins about the middle of July, and consists of six weeks' practical work in the field. The work is practically confined to the Pre-Cambrian rocks of the Lake Superior region.

A few days of the course are spent at compass work, in which the student is trained in the use of the dial and dip compasses and aneroid barometer. This work consists of running section lines, meandering roads and streams, and platting outcrops; in fact, making a complete map of the traverses. Specimens are collected and located with reference to some monument established by the United States linear survey. The student plats all of his work in the field, keeping his latitude and departure by means of his compass course and pacing.

After the students become more or less adept at platting and compass work they are given small special areas to map in detail,

and to work out the relation of the rocks. They make sections and plans showing these relations, and are required to write descriptions of the specimens collected, and to explain the geological phenomena observed.

Considerable time is spent in the study of the older granites, gneisses and hornblende schists, etc., with their varied accompaniment of tuffs and basic and acid intrusives which comprise the basement complex. Here the various acid and basic dike rocks are studied in their relation to one another and to the older schists. Vein phenomena are also studied at the various openings along the gold range northwest of Ishpeming.

Most of the time is spent in studying the "Algonkin" clastics that rest uncomformably upon the older Basement Complex. These clastics in the Marquette Iron-Bearing District are found to be capable of division into a lower, a middle and upper series, termed respectively the "Lower Marquette," "Middle Marquette" and the "Upper Marquette" series. These series are separated from each other by unconformities. Large bodies of iron ore are associated with the middle and upper series. The ore bodies are studied with reference to their origin, and maps and sections are made showing their mode of occurrence, and their relation to the associated rocks.

The department is well equipped with the instruments necessary for this work, and note books with special rulings are furnished the students at cost.

All students entering the college for instruction in this subject (Y 4) only, should have a fair knowledge of Mineralogy, Lithology and General Geology, if they wish to fully profit by the course. The other students at the College who are candidates for degrees, in order to take this subject are required to have passed in Q 1 (Surveying) and Y 2 (Historical Geology).

Y 5. Economic Geology.

Mr. Bowen.

Three times a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. Prerequisites, W 3 (Mineralogy), X 2 (Petrography), Y 4 (Field Geology). The course includes a discussion of the genesis of ore-deposits and a careful consideration of the useful metallic and non-

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metallic minerals; the deposits of the United States receive especial consideration. Foreign occurrences are treated as time will permit.

The aim is to make the course as practical as possible. To this end the uses, mode of occurrence, distribution, origin, technology and facts which bear upon the commercial value of ores and minerals are especially considered.

Students are required to make abstracts of professional and technical reports for presentation before the class. All students are held responsible for a knowledge of the data given in such reports.

The laboratory is well equipped with material representative of the subject from the United States and foreign countries. Students are required to spend sufficient time in the laboratory to thoroughly familiarize themselves with this material.

J. THESIS.

The Faculty.

J 1. Thesis.

Properly qualified students may include the preparation of a thesis in their work for a degree. To count as one credit.

The subject of such thesis must be announced with the schedule of studies for the year in which the degree is expected; further, the schedule must be approved by the head of the department in which the thesis work is to be done. This approval will include the subject chosen and the student's preparation to do the work.

The schedule and subject are then considered by the Faculty, whose approval is necessary.

The thesis must be completed by July 1, and submitted to the Faculty for examination and acceptance. For its acceptance it must be accompanied with a written approval of the instructors under whom the work was done.

DEGREES

The approximate unit of credit is assumed to be three hours a week in the class room (approximately nine hours of total work) or nine hours a week in the laboratory for thirty-three weeks. A subject scheduled for more or less time than here indicated takes its proportionate credit. No partially completed course may be accepted for credit either in whole or in part. The College is in session for four terms each year. It is therefore possible for a properly prepared student to cover the ordinary twelve term course in three years.

Three degrees are offered by the College as follows:

Bachelor of Science, B.S.

Engineer of Mines, E.M.

Doctor of Philosophy, Ph.D.

The conditions under which the first two are given are as follows:

To obtain either degree the candidate must have been a resident student of this institution for at least one full year of forty-five weeks.

All candidates for the degree of Bachelor of Science are required to obtain twenty credits, including subjects R 1 (Principles of Mining), W 4 (Elementary Mineralogy and Crystallography), and Y 1 (Principles of Geology).

All candidates for the degree of Engineer of Mines are required to obtain twenty-five credits, including subjects R 1 (Principles of Mining), W 4 (Elementary Mineralogy and Crystallography), and Y 1 (Principles of Geology).

All students who have been granted the degree of Engineer of Mines may obtain the Bachelor of Science degree on payment of the required fee.

All students who graduated from this institution prior to 1896,

with the degree of Bachelor of Science, may receive the degree of Engineer of Mines, on the presentation of evidence showing five years of subsequent successful practical work, submitting a satisfactory thesis, and paying the required fee.

The degree of Ph.D. will be given under the following conditions:

A student who has received the degree of Engineer of Mines from the Michigan College of Mines, or who is a graduate of another institution of similar grade, whose courses are approved by the Faculty, may be admitted as a candidate for the degree of Doctor of Philosophy. In order to attain this degree he must pursue, for at least two years, advanced study in subjects allied to the work of this institution, which subjects are approved by the Faculty.

One of the years may, in special cases, be spent elsewhere, and the work may be accepted, on sufficient proof of its thoroughness and high character, as the equivalent of one year's work done here. But under no condition will this degree be given to anyone unless at least one year of forty-five weeks of actual work be done by him as a resident student in this institution.

Students who have received the degree of Engineer of Mines from this College, or who are graduates of an equivalent professional school, and who are also arts graduates of some college or university whose course of study is accepted by the Faculty, may be admitted to the degree of Doctor of Philosophy, after having taken, for at least one year of forty-five weeks, an approved course of study at this institution.

The degree of Doctor of Philosophy will be given only in case the candidate shall have shown marked ability and power in original investigation, and his thesis shall have received the approval of the Faculty.

Fees.

Bachelor of Science	$15 00
Engineer of Mines	25 00
Doctor of Philosophy	50 00

No degree will be conferred until the required fee has been paid, which payment must be made to the Treasurer prior to August 15.

DEGREES CONFERRED AUGUST 29, 1904

ENGINEER OF MINES

Anderson, Robert Hutchison,	*Southerton, Kirkcaldy, Scotland.*
Bailey, Marc,	*Chanute, Kan.*
Bauder, William Ralph	*Chicago, Ill.*
Caulfield, John Joseph, Jr.,	*Grand Rapids.*
Chope, William Edward,	*Detroit.*
Cram, Frederick William,	*Escanaba.*
Deane, Willard Albert,	*Saginaw.*
Devine, Henry Edward,	*Ishpeming.*
Donahoe, Frank Timothy,	*Ishpeming.*
Drew, Charles Verner,	*Chicago, Ill.*
Fink, William Nelson,	*Milwaukee, Wis.*
Gallagher, John Hubert,	*North Yamhill, Ore.*
Garrey, George Henry,	*Chicago, Ill.*
Gates, Charles Cassius,	*Clarkston.*
Goodman, Francis Benjamin,	*Sands.*
Gordon, William Crosgrove,	*Port Rowan, Can.*
Johnson, John Saras,	*Calumet.*
Johnson, Ralph Browning,	*Houghton.*
Jordan, Fred Allen,	*Ottawa, Ill.*
Lang, Sidney Sherman,	*Houghton.*
Lockhart, Carl Brown,	*Chicago, Ill.*
Marshall, Cyrus Buxton,	*Nashville.*
Maxwell, Harry West,	*Chicago, Ill.*
Morrison, George Adelbert,	*Coldwater.*
Norton, James Thomas,	*Houghton.*
Oliver, Robert Sheldon,	*Escanaba.*
Pascoe, William,	*Republic.*
Rakowsky, Victor Hugo,	*Duluth, Minn.*
Robinson, Glen,	*Lansing.*
St. Clair, William Rood,	*Ishpeming.*
Salisbury, Earl Fremont,	*Houghton.*
Siau, Robert Holmes,	*Detroit.*
Soddy, Francis Joseph,	*Calumet.*
Steubing, William Colson,	*Louisville, Ky.*
Stewart, Jesse Arthur,	*Arcadian Mine.*
Story, Ralph Whitney,	*Milwaukee, Wis.*
Sumner, George Howard,	*Detroit.*

Thomas, Philip Porter,	*West Superior, Wis.*
Turner, Scott,	*Lansing.*
Walker, Myron Reed,	*Houghton.*
Wheeler, Zenas Frank,	*Ann Arbor.*
Williams, John Prydderch, Jr.,	*Detroit.*
Williams, Percival Sherman,	*Ironwood.*
Wright, Louis Aldro,	*San Antonio, Tex.*

BACHELOR OF SCIENCE

Adams, Clement Lawerson,	*Sault Ste. Marie.*
Anderson, Robert Hutchison,	*Southerton, Kirkcaldy, Scotland.*
Bailey, Marc,	*Chanute, Kan.*
Brooks, George Sage,	*Milwaukee, Wis.*
Caulfield, John Joseph, Jr.,	*Grand Rapids.*
Chope, William Edward,	*Detroit.*
Devine, Henry Edward,	*Ishpeming.*
Dodge, Charles Warren, Jr.,	*Milwaukee, Wis.*
Fink, William Nelson,	*South Milwaukee, Wis.*
Goodman, Francis Benjamin,	*Sands.*
Johnson, John Saras,	*Calumet.*
Jordan, Fred Allen,	*Ottawa, Ill.*
Lang, Sidney Sherman,	*Houghton.*
Lockhart, Carl Brown,	*Chicago, Ill.*
Marshall, Cyrus Buxton,	*Nashville.*
Maxwell, Harry West,	*Chicago, Ill.*
Morrison, George Adelbert,	*Coldwater.*
Parkhurst, Frederick Shrewsbury, Jr.,	*Medina, N. Y.*
Pascoe, William,	*Republic.*
Robinson, Glen,	*Lansing.*
St. Clair, William Rood,	*Ishpeming.*
Stewart, Jesse Arthur,	*Arcadian Mine.*
Story, Ralph Whitney,	*Milwaukee, Wis.*
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EMPLOYMENT

To one contemplating entering upon training for any particular profession, the question, will it pay? is one of deep and often of disproportionate interest. In reference to a Mining Engineering training this question generally resolves itself into the more specific inquiry: what are the chances of obtaining a position upon graduation? Regarding this question it may be said that, with the increasing interest in mines and mining, in this and other countries, the demand for competent mining men is on the increase, and at the present time it seems that Mining Engineering offers opportunities at least as wide as are offered by any other line of engineering.

It should be clearly understood that the Michigan College of Mines makes no promise whatever to secure positions for its graduates. Upon graduation each man goes into the market to sell his services, meeting the same conditions as every other technical graduate in mining, whether prepared at this or another college. At the same time the College takes an interest in its graduates. Each one is urged to keep the institution informed of his whereabouts, his work, and whether or not he desires a change. From information thus gained a record is made and kept as nearly up to date as possible. When the College is asked to recommend a man for a given position, this record is looked over and the most available man is selected from it. In no case is a man recommended merely because he is a graduate of this institution. In selecting him his experience, his character and his general ability, both as shown in his work as a student and in his career after he leaves the College, are taken into account. His defects, if known, are stated as carefully as are his aptitudes or excellencies, and no one is recommended unless he is deemed fit for the position.

Prospective students and those responsible for them should understand that the College cannot impart traits of character. The best it can do is to help the student develop properly those character-

istics which he already possesses. His advancement in his profession will depend quite as much upon his character and ability as upon his technical training, whether gained in college or out of it. When through his college course, he will, if his work has been properly done, be ready to begin his career in mining.

The location of this institution and its methods of instruction fit its graduates to be useful to their employers in some capacity at the start, and so far they have upon graduation experienced no difficulty in obtaining positions which give them a chance to show forth the material of which they are made. Subsequent advancement depends upon the character and the ability of the individual. His industry and the faithfulness with which he devotes himself to the interests of his employer are two most important factors.

In conclusion it may be said that only those who are willing to do hard and continuous work, both during their course at college and in the years following, should undertake to train for a career in mining. For those who are thus willing, and who have an aptitude for engineering pursuits, the outlook is promising.

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LIBRARY

The Library, located on the second floor of Hubbell Hall, is designed to supplement the class work in the various departments of the College. Care has been taken to supply it with the best reference books as well as with the latest publications on the subjects taught, since it is of prime importance that instructors and students shall have access to the results of the most recent researches in scientific and technical lines. It should be noted in this connection that there is no other Library in the vicinity to which those needing such information can apply. The Library is especially rich in files of journals relating to the various branches of mining engineering. Upon its shelves may be found complete sets of such journals as Transactions of the American Institute of Mining Engineers, Annales des Mines, Jahrbuch für das Berg-Huetten und Salinenwesen, Journal of the Iron and Steel Institute, Philosophical Transactions of the Royal Society of London, Proceedings of the Royal Society of London, Wiedemann's Annalen der Physik und Chemie, Zeitschrift für Analytiche Chemie, Transactions of the American Society of Mechanical Engineers, Zeitschrift des Vereins deutscher Ingenieure, and many others of like character.

A card catalogue of authors and subjects which has been under way for some time is now complete, rendering the Library more valuable. The classification is an adaptation of the Dewey decimal system to the needs of a technical library.

There are now on the shelves 19,809 volumes. The Library receives as gifts a number of United States documents and reports of various state geological surveys and mining bureaus.. Such material is very useful, and grateful acknowledgment is made for all contributions of scientific value.

Besides the bound volumes on the shelves, the Library contains over 4,500 pamphlets, classified and accessible for reference, and a large number of maps.

There are on file 252 technical and scientific periodicals, which are issued upon application for use in the reading room which adjoins the Library.

The Library is open daily throughout the year, Sundays and legal holidays excepted. While it is intended primarily as an aid to college work, the College authorities are pleased to extend its privileges to such part of the general public as may wish to use it. Mining engineers, and those interested in scientific or technical pursuits, will find it a valuable aid in research work.

BUILDINGS

The laboratories and the library of the College together with its lecture and recitation rooms at present occupy six buildings.

Hubbell Hall, formerly known as Science Hall, is constructed of Portage Entry sandstone and has extreme dimensions of 109 by 53 feet, with a wing 37 by 25 feet. It contains the executive offices, the Library and Reading Room, and the laboratories and lecture rooms of the departments of Geology, and of Mathematics and Physics.

The Physical laboratories are located on the ground floor. They have been recently fitted up with modern conveniences for laboratory instruction. There is a massive pier for instruments requiring extreme stability, while slate shelves firmly attached to the thick basement walls afford very stable supports for galvanometers and other like instruments. These rooms contain many features especially designed by the instructors in charge to meet the peculiar needs of this department. They are well lighted and well adapted to their purpose.

On this floor in the tower is a constant temperature and dark room surrounded by thick stone walls. It is used partly for work in light, and partly for electrical and other measurements where a steady temperature is desirable.

The Physical lecture room is located on the second floor of this building and contains a convenient lecture table fitted with electrical, gas and water supply.

The laboratories of the department of Geology and Mineralogy together with the necessary offices occupy the entire first floor.

The Library, Reading Room and executive offices are on the second floor, while the Mathematical lecture and recitation rooms and a Geology and Mineralogy Museum occupy the entire third floor.

The Chemistry Building is 115 by 45 feet, with wings 36 by 17

feet and 53 by 36 feet in size. It is a brick and stone structure of three stories in height.

This building has a forced draft ventilation system.

It contains the laboratories for General Chemistry, Qualitative Analysis, Quantitative Analysis, and for special work, together with chemical lecture room and the necessary recitation and supply rooms.

The Assay Laboratory is a brick structure 99 by 24 feet in size, standing north of Hubbell Hall. It contains a general furnace room 56 by 21 feet in the center of the building. The western end is occupied by a supply room 15 by 13 feet and a weighing room 12 by 21 feet. In the eastern end of the building there is a parting room 10 by 21 feet, fitted with desks and hoods for the parting of gold and silver. This building connects by a covered passage-way with the Chemistry Building which adjoins it.

The Mechanical Engineering Building, of brick and stone, is of the extreme dimensions 101 by 64 feet. It contains the room used by the department of Mechanical and Electrical Engineering. The Mechanical Drawing Room on the second floor of this building is an exceptionally well lighted room and well adapted for its purpose. In addition the building contains the wood-working shop, the machine shop, electrical laboratory, testing laboratory, together with lecture and recitation rooms.

A wing contains a fuel room 33 by 16 feet and a boiler room 33 by 29 feet. In the latter are located the boilers which supply heat and power to the whole institution. There are three, two of the water tube type and one of the return tubular type.

A second wing 43 by 26 feet in size has been constructed to accommodate a blacksmith shop.

The Ore Dressing Building is a wooden structure with main part 30 by 30 feet, two stories in height and an extension 51 by 30 feet. It occupies a slope on the eastern side of the College grounds which gives the requisite fall for gravity processes.

There is also a Reverberatory Roasting Furnace in a wooden building 28 by 28 feet. This furnace is operated in connection with the Ore-Dressing mill.

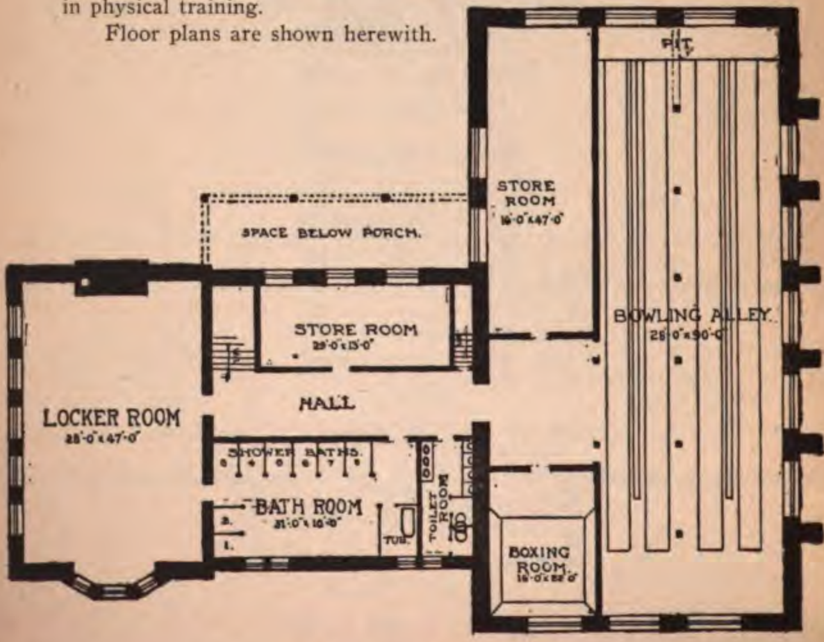
The Mining Engineering Building is 134 by 53 feet, three stories in height, and is built of brick and stone. In the center of the

Gymnasium.

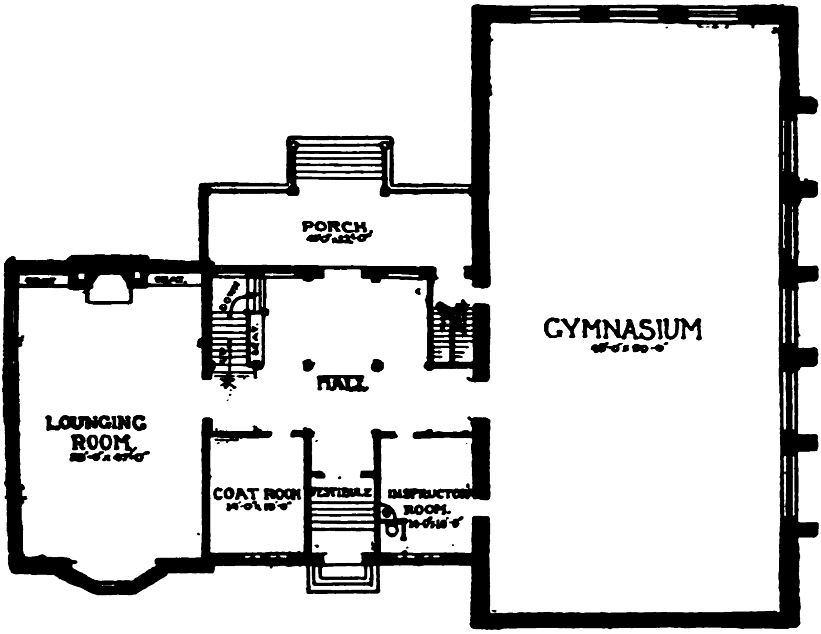
Generous friends of the College of Mines, including the members of the Board of Control, have joined with the staff and students in contributing a fund for the erection of a building to be used as a College Gymnasium and Club House. At the time of issuing this Yearbook the building is nearing completion, and it is expected that it will be in commission at the opening of the college year 1905-1906. It is a plain but commodious building, admirably adapted to serve the dual purpose of Gymnasium and Club House. It will give the school an auditorium 45 by 90 ft. in the clear. The building is also designed to serve as a suitable place for such social functions as are given by the students of the institution. Altogether it will contribute very materially to the social life of the College, and those who have so generously donated to the fund are deserving of the greatest praise for their substantial appreciation of the needs of the College.

The Gymnasium will be in immediate charge of the instructor in physical training.

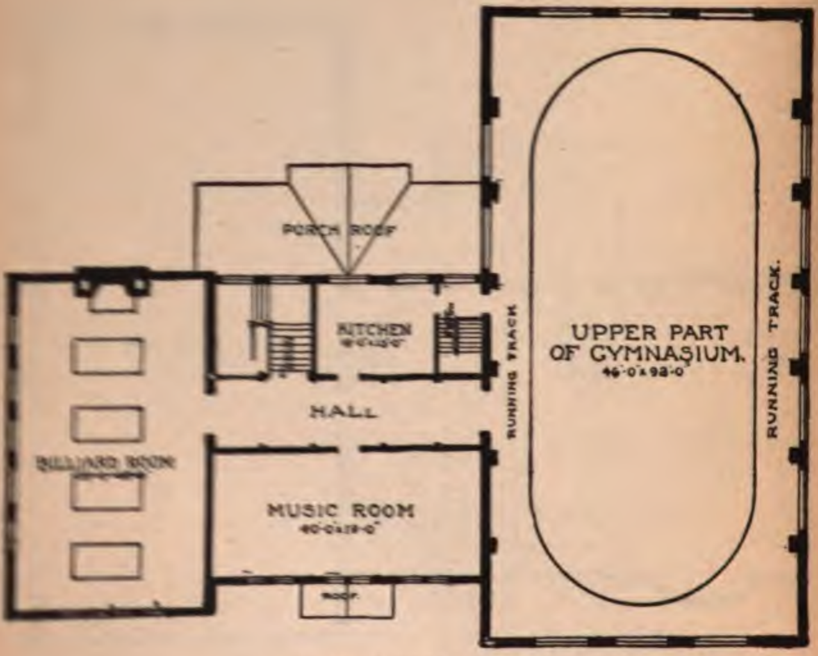
Floor plans are shown herewith.



BASEMENT PLAN



FIRST FLOOR PLAN



SECOND FLOOR PLAN

TUITION, DEPOSIT AND OTHER EXPENSES

The Michigan Legislature of [illegible] required the Board of Control to charge matriculation, [illegible] and [illegible] fees. Since the people of Michigan had by [illegible] paid for the College buildings and equipment it was thought by the Legislature that those persons whose homes were outside the State [illegible] to pay higher matriculation and tuition fees than the residents of the State.

The law provides that the matriculation fee "Shall be not less than ten dollars for all persons who have been bona fide residents of this State for not less than one year immediately preceding their matriculation as students in said institution, and not less than twenty-five dollars for all others; and that tuition shall be twenty-five dollars per year to resident students as above defined." Tuition for all others is one hundred-fifty dollars per year.

All expenses for breakage or damage to apparatus will be paid for by the student, as the laboratory fees do not cover these items.

The matriculation fee must be paid on entrance to the College. The full tuition fee for Michigan students must be paid on entrance, but other students are required to pay the proportionate part of the tuition fee at the commencement of each term for that term as follows: Fall, Winter and Summer terms, [illegible] each term. Spring term, $30.00.

Laboratory fees are due when the course involving the laboratory work begins. They must be paid before the student can be admitted to the laboratory.

No partial fee can be accepted, and any fee once paid can not be refunded except in the case of protracted illness.

A student suspended, dismissed or expelled from, or voluntarily withdrawing from a class, laboratory, or the College, forfeits the fees already paid.

The scale of fees is as follows:

TITLE	Students residing in Michigan	Students residing outside of Michigan
Matriculation Fee	$ 10 00	$ 25 00
Tuition Fee, Annually	25 00	....
" " Fall term	....	40 00
" " Winter term	....	40 00
" " Spring term	....	30 00
" " Summer term	....	40 00
LABORATORY FEES		
B 1—Physics	3 00	3 00
B 2—Physical Measurements	2 00	2 00
B 3—Electrical Measurements	3 00	3 00
B 4—Physics	2 00	2 00
B 5—Light	1 00	1 00
F 1—Chemistry	10 00	10 00
F 2—Blowpipe Analysis	1 00	1 00
F 3—Qualitative Analysis	10 00	10 00
F 4—Volumetric Analysis	3 00	3 00
F 5—Quantitative Analysis	10 00	10 00
F 6—Synthetic Chemistry	10 00	10 00
F 7—Quantitative Analysis	7 00	7 00
G 1—Assaying	15 00	15 00
G 3—Metallurgical Laboratory Practice	10 00	10 00
G 7—Practice Work in Metallurgy	....	....
M 2—Shop Practice	10 00	10 00
M 3—Design of Structural Joints	50	50
M 6—Testing Materials	10 00	10 00
M 9—Mechanical Laboratory	10 00	10 00
M 15—Mechanical Drawing	1 00	1 00
M 16—Machine Drawing	1 00	1 00
N 3—Electrical Engineering Laboratory	5 00	5 00
Q 1—Surveying	10 00	10 00
Q 3—Hydraulics	5 00	5 00
Q 4—Topographical Drawing	1 00	1 00
Q 5—Surveying	2 00	2 00
R 3—Mine Surveying Practice	10 00	10 00
S 2—Ore Dressing	5 00	5 00
S 3—Practice Work in Ore Dressing	....	....
V 2—Palæontology	5 00	5 00
W 1—Crystallography	2 00	2 00
W 2—Mineralogy	10 00	10 00
W 3—Mineralogy	5 00	5 00
W 4—Elementary Mineralogy and Crystallography	....	....
X 1—Petrography	5 00	5 00
X 2—Advanced Petrography	....	....
Y 4—Field Geology	5 00	5 00

[redacted]

In order partially to insure the State against damage and loss to its College property every student is required to deposit with the treasurer before entering the College, the sum of twenty-five dollars ($25). This sum cannot be withdrawn by the student until he closes his connection with the institution, and if any portion is required as a refund for damages, the part withdrawn shall be at once replaced by the student.

Charges for apparatus, chemicals and other supplies from the store room, as well as for repairs of damages to College property, and also fines, are deducted from coupons procurable from the secretary, but no portion of the deposit of twenty-five dollars shall be used for the purchase of these coupons. The coupons can be used only for the purposes mentioned, and not for the payment of any fees. The permanent deposit of twenty-five dollars, together with any balance equivalent to the unused portion of a coupon, is returned to the student when he closes his connection with the institution.

There are no dormitories connected with the College. Arrangements can be made to obtain board and room in private families, and in boarding houses, in Houghton and Hancock, at prices varying from twenty-five dollars per calendar month upward. This is to include the room, heat and lights, as well as board. Board alone can be obtained at about twenty dollars per calendar month. The College expenses vary much with the taste and habits of the student. With care the cost to a Michigan student need not exceed $450.00 per year.

REGULATIONS

Choice of Studies.—Upon entering the College the student will present his choice of studies for the year.

On or before the last Saturday of the College year, all students intending to remain during the coming year will hand to the secretary duplicate written lists of studies chosen for that year. All candidates for a degree are required to take courses R 1 (Principles of Mining), and Y 1 (Principles of Geology). Apart from these the choice of subjects is governed by the following regulations:

In selecting the subjects for any year the student must observe the schedule both for terms and hours as given in the tables at the end of the catalogue. He must also pay attention to the proper sequence of subjects and avoid choosing subjects for which he has not covered the required preceding work. In exceptional cases a student may be allowed to take a subject out of its order, but when the work is so taken, no credit will be given for it until the required preparatory work has been made up.

After the subjects have been chosen for the year, a student can change, drop or take up any study only in the following manner: He is to hand to the secretary a written request, stating the change desired and the reasons therefor. This petition before it is given to the secretary is to bear the written approval of the instructors whose work is affected by the proposed change. If it is then approved by the president, the change may be made, and the secretary will give the student a notice which he is to show to the instructors interested before any change in the attendance upon classes is made. The work already done in the subject from which the change is made will not be counted, and the student must complete the required work in the subject to which he is transferred, as if the latter subject had been originally chosen.

A student who drops or takes up a course except in the manner here stated will be considered as having withdrawn from the Col-

lege, and will stand suspended from all exercises in the institution.

If at any time a student is found to have work insufficient to properly occupy his time, he may be required to take additional subjects. If a student has elected more work than he can properly perform he may be required to drop some of the subjects.

Each instructor is the sole judge of the fitness of every student electing his subjects. He may refuse to admit into his class any student found deficient in preparation, or dismiss him from his courses at any time when his conduct or work is unsatisfactory.

Absences.—All absences being a daily mark of zero, until the work missed is made up.

A student absenting himself without excuse for more than ten per cent. of the work of any course in any term thereby dismisses himself from the College. In the case of field or laboratory courses, the limit is five per cent. instead of ten per cent.

Each tardiness counts a half absence.

Passing Grade.—A student must obtain a grade of 75 on the scale of 100 to obtain credit for any course. In case of failure to pass or complete a subject, the work can be made up only when this subject is being regularly given.

Failure.—A student who fails in three subjects or who receives conditions in three subjects in any year's work, is thereby dismissed from the College.

Laboratories.—The laboratories close Friday evening the closing day of each term, and re-open on Monday morning after the recesses.

PRIZES AND SCHOLARSHIPS

THE LONGYEAR PRIZES

Through the liberality of Hon. J. M. Longyear, of Marquette, the following prizes have been offered, as stated in his letter which is here appended:

MARQUETTE, Michigan, Nov. 9, 1887.

Charles E. Wright, Esq., Marquette.

DEAR SIR—I wish to offer three first prizes of seventy-five dollars ($75) each, and three second prizes of fifty dollars ($50) each to be competed for by the members of the senior class of the Michigan College of Mines. The competition to be by means of papers on three subjects, written by members of the class, and submitted to the Board of Control for examination in such a manner and at such a time as the Board may determine. I desire subjects selected with a view of producing papers which will be of practical use in developing the mineral resources of the State of Michigan. I should like something which would be of service to the average woodsman or explorer, and suggest the subjects of Practical Field Geology, and the use of the Dial and Dip Compass in explorations; leaving the selection of the third subject to the judgment of the Board. If this offer is accepted and there are two or more papers on each subject submitted, I will pay seventy-five dollars to each of the writers of the three papers which may be awarded the first prizes, and fifty dollars to each of the writers of the three papers which may be awarded the second prizes.

I would suggest, however, that in case only two papers are submitted, the Board reserve the right of awarding only one prize, in case such action should seem advisable. In case only one paper should be submitted, I should like the Board to exercise its judg-

ment in awarding a prize. It is my desire to publish the papers under the writer's name, in pamphlet form, for distribution among miners, explorers, land owners and others.

Yours very truly,

J. M. LONGYEAR.

In conformity with the foregoing letter, the Board of Control have decided upon the following subjects and conditions:

SUBJECTS.

1. Field Geology; its Methods and their Applications.
2. The Dial and the Dip Compass and their Uses.
3. The Diamond Drill and its Uses.

CONDITIONS.

The conditions under which the prizes are awarded are as follows:

The papers are to be presented by August 15th, for each year.

A student may present a paper upon each of the three subjects, which will entitle him to three prizes, if his papers are found worthy.

The dissertations must be prepared in the same manner as the theses, the regulations for which can be procured on application to the secretary of the College.

The title page is to have upon it an assumed name, and each paper is to be accompanied with a sealed envelope bearing the same name. This envelope must contain the writer's true, as well as assumed name, and his address. It will not be opened until the awards have been made.

No prizes will be awarded, unless the papers are judged by the committee to whom they are referred, to be of a sufficiently high standing to be entitled to a prize; hence, there may be awarded all, part, or none of the prizes, as the case may be.

These prizes can now be competed for by any student of the College, whether special, graduate or regular, without restriction to the graduating class, as was originally specified.

THE CHARLES E. WRIGHT SCHOLARSHIP.

The Charles E. Wright Scholarship was founded by Mrs. Carrie A. Wright, of Ann Arbor, in accordance with the conditions expressed in the letter which follows:

To the Honorable Board of Control of the Michigan College of Mines.

GENTLEMEN—In memory of my husband, the late Charles E. Wright, and as a token of the deep interest he had in the Michigan College of Mines, I desire to give to said College the sum of one thousand dollars.

If said gift shall be accepted, it is to be held under the following conditions:

To wit; it is to be invested as a permanent fund by the Board of Control to form the nucleus of a scholarship to be known as the Charles E. Wright Scholarship. The income is to be used for the purpose of aiding indigent students by loans under the following regulations: Loans from this income may be granted by the Board of Control upon the recommendation of the Faculty to students who have completed at least one year of study at the Michigan College of Mines, who have for the entire time of this residence a good record as to character and scholarship; who, further, intend to devote themselves to the profession of mining engineering or geology, and who are deemed deserving and needy.

Upon receipt of a loan from this Scholarship the student shall give his note for the amount of same. This note shall bear interest at the rate of five per cent. per annum from the date of his graduation or of leaving the College until paid, and shall be due on or before five years from such date.

Amounts paid on such notes shall go to increase the money to the credit of the Charles E. Wright Scholarship Fund.

(Signed) CARRIE A. WRIGHT.

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THE NORRIE SCHOLARSHIP.

This scholarship was founded, and will be awarded in accordance with the conditions and requirements stated below:

Know all men by these presents, That I, A. Lanfear Norrie, of the City of New York, hereby give, grant, assign, and set over unto the Michigan College of Mines, of Houghton, Michigan, and to Peter White, D. H. Ball and J. M. Longyear, of Marquette, Michigan, as trustees, the sum of ten thousand dollars ($10,000), lawful money of the United States.

The conditions of this gift, and upon which this fund is to be taken, are that the said trustees shall invest the same upon bond and mortgage in the Village of Marquette, or in the City of Detroit, in the State of Michigan, or in the City of Milwaukee, in the State of Wisconsin, or in the City of Chicago, in the State of Illinois, upon unincumbered improved real estate.

That one-half of the income of said sum of $10,000 shall be paid yearly by said trustees unto the Board of Control, for the support of some student whose father has worked in, or in some way been connected with, mining operations in the Upper Peninsula of Michigan, who shall be designated by the Faculty of said College; and the remainder of said income shall be accumulated and invested as said principal shall be invested, and that this fund with its accumulations shall be the basis of a larger fund, to be obtained from other contributions, amounting to at least one hundred thousand dollars ($100,000), to be used for the erection of a Dormitory Building for the use of such students as shall be designated by said Faculty; which building, when erected, shall be under the exclusive control of the corporation or Board of Control of the said Michigan College of Mines.

This gift is to the said trustees and their successors forever, for the benefit of the said College. In case of the death of either of said trustees, the survivors or survivor shall appoint a successor or successors.

When the erection of said building shall be commenced, after the said fund of one hundred thousand dollars is obtained, the sum

hereby given, with all its accumulations, shall be paid over to the said College for the purpose aforesaid.

Witness my hand, the 30th day of January, 1890.

A. LANFEAR NORRIE.

Witness, T. E. O. M. STETSON.

We, Peter White, D. H. Ball and J. M. Longyear, the persons named in the above instrument, accept the trust therein granted, in all respects, and agree to comply with the conditions thereof.

Witness our hands, the 1st day of February, 1890.

PETER WHITE,
D. H. BALL,
J. M. LONGYEAR.

THE LONGYEAR FUND.

This is a fund of $2,500, given by the Honorable J. M. Longyear, of the Board of Control, to be the property of the College of Mines, to be used in aiding students of the College by loans in cases where the said students are unable to maintain their connection with the College without such aid.

The conditions governing loans from this Fund are as follows: Loans may be granted by the Board of Control, upon the recommendation of the Faculty of the College to students who have completed at least one term of study at the College of Mines, who have for the entire time of residence a good record as to character and scholarship, who are deemed worthy and needy, and who shall be recommended by two responsible persons not connected with the College.

Upon receipt of a loan from this fund, the student shall give his note for the amount of same. This note shall bear interest at the rate of five per cent. per annum for the first three years from the date of his graduation or his leaving the College, and for the following two years at the rate of seven per cent. per annum. It will then be due.

This method of loaning is believed by the donor and the College to be of more benefit to the student than a gift outright, since it gives him the opportunity to pay for his own education while offering him assistance when he most needs it. It is thought that it would be better if all funds given to the College for the aid

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of students were accompanied with a proviso that the proceeds should go as a loan to the student rather than as a gift. Certainly the manly student hesitates to receive aid which savors of charity. It is a kindness if he can be aided in a way that will save his self-respect.

THE ALLIS-CHALMERS COMPANY SCHOLARSHIP.

The Allis-Chalmers Company of Chicago, the great manufacturers of mining and heavy machinery, offer to one member of each year's graduating class a course of four months' employment in their shops, with the addition of the sum of $150.00.

This scholarship obviously carries most excellent opportunities for practice in connection with mining machinery. It will be awarded by the Board of Control, on recommendation of the Faculty, to some graduate who has made application for it, and who has shown sufficient proficiency in mechanical lines to warrant his receiving it.

Application should be made to the Faculty as early as July 15th of each year in which the student expects his degree.

MICHIGAN LOAN SCHOLARSHIPS.

By virtue of the power conferred by Act No. 81, Public Acts of 1897, the Board of Control have established twelve scholarships under the above title. These are open to Michigan students under the following regulations:

The scholarship may be granted by the Faculty of the College to students who are bona-fide residents of the State of Michigan, who have completed at least three terms of study at the College of Mines, who have during this entire time a good record as to character and work as students, and who are deemed deserving and needy.

Each scholarship is to be granted for the College year or the unexpired portion thereof, but the same student may at the option of the Faculty receive the grant more than once.

Each scholarship shall remit to the recipient the tuition and laboratory fees for the time for which he holds it, provided, however,

the amount so remitted shall not exceed $75 in any one college year.

If at any time the work or conduct of the holder of one of these scholarships becomes unsatisfactory to the Faculty, he shall be deemed to have forfeited the scholarship.

Upon receiving the grant of a scholarship the recipient shall give his note for the amount of same. The note shall bear interest at the rate of six per cent. per annum from the date of his leaving the College until paid, and shall be due on or before five (5) years from such date.

Amounts paid on such notes shall constitute a fund to be known as the Loan Scholarship Fund, which fund shall be devoted to assisting needy and worthy students by cash loans.

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TEXT BOOKS

A. MATHEMATICS.

A 1. College Algebra. G. A. Wentworth. Ginn & Co., Boston.

A 2 and 3. Plane and Spherical Trigonometry. W. Wells. Heath & Co., Boston.

A 4. Analytic Geometry. Tanner and Allen. American Book Co., New York.

A 5. Manuscript Notes on Calculus. Issued by the department.

A 5. Differential and Integral Calculus. J. M. Taylor. Ginn & Co., Boston.

A 6. A Treatise on Ordinary and Partial Differential Equations. W. W. Johnson. John Wiley & Sons, New York.

B. PHYSICS.

B 1 and 4. Manuscript Notes in Physics. Issued by the department.

B 1 and 4. Laboratory Course in Physics. Last Edition. W. C. Sabine. Ginn & Co., Boston.

B 1 and 4. Heat and Light. R. T. Glazebrook. The Macmillan Co., New York.

B 1. Mechanics for Beginners. J. B. Lock. The Macmillan Co., New York.

B 4. Elementary Electricity and Magnetism. D. C. and J. P. Jackson. The Macmillan Co., New York.

B 2 and 3. A Laboratory Manual of Physics and Applied Electricity. E. L. Nichols. The Macmillan Co., New York.

B 2. Lessons on Elementary Practical Physics. Vols. I and II. Balfour Stewart and W. W. Haldane Gee. The Macmillan Co., New York.

B 3. Electrical Measurements. H. S. Carhart and G. W. Patterson, Jr. Allyn & Bacon, Boston.

C. MECHANICS.

C 1 and 2. Mechanics of Engineering. I. P. Church. John Wiley & Sons, New York.

F. CHEMISTRY.

F 1. Lectures on General and Experimental Chemistry. George A. Koenig.

F 1. Inorganic Chemistry. Richter, Smith. P. Blakiston, Son & Co., Philadelphia.

F 1. Manuscript Notes on Experimental Chemistry. G. A. Koenig.

F 1. Treatise on Chemistry. Roscoe & Schorlemmer. D. Appleton & Co., New York.

F 2. Manual of Determinative Mineralogy. Edition 13. George J. Brush. John Wiley & Sons, New York.

F 2. Landauer's Blowpipe Analysis. 1892. Translated by James Taylor. The Macmillan Co., New York.

F 3. Notes on the Chemistry of Metals and the Analytical Relations of the Metallic Compounds. G. A. Koenig.

F 4. Electrolytic Methods. E. F. Smith. J. B. Lippincott Co., Philadelphia.

F 7. A System of Instruction in Quantitative Chemical Analysis. C. R. Fresenius. Edition 10. Edited by O. D. Allen and S. W. Johnson. John Wiley & Sons, New York.

F 7. Manuscript Notes in Quantitative Analysis. 1895-1896. G. A. Koenig.

F 6. Theoretical Chemistry. Ira Remsen. Lea Bros. & Co., Philadelphia.

F 6. Elements of Physical Chemistry. H. C. Jones. The Macmillan Co., New York.

F 6. Introduction to Physical Chemistry. J. Walker. The Macmillan Co., New York.

G. METALLURGY.

G 1. Manuscript Notes on Assaying. 1895. George A. Koenig.

G 1. Introduction to the Study of Metallurgy. Roberts-Austen. J. B. Lippincott Co., Philadelphia.

G 1. Manual of Assaying. A. S. Miller. Engineering and Mining Journal Co., New York.

G 2. Metallurgy of Lead. Last Edition. H. O. Hofman. Scientific Publishing Co., New York.

G 2. Modern American Methods of Copper Smelting. Last Edition. E. D. Peters. Scientific Publishing Co., New York.

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G 2. Fuel and Refractory Materials. A. H. Sexton. Blackie & Sons, London.

G 2. Metallurgy of Zinc. W. R. Ingalls. Engineering and Mining Journal Co., New York.

G 2. Cyanide Practice. A. James. Engineering and Mining Journal Co., New York.

G 2. Metallurgy of Gold. T. K. Rose. J. B. Lippincott & Co., Philadelphia.

G 2. Metallurgy of Silver. H. F. Collins. J. B. Lippincott & Co., Philadelphia.

G 2. Handbook of Metallurgy. C. Schnabel. Translated by H. Louis, 1898. The Macmillan Co., New York.

G 2. The Cyanide Process. J. Park. J. B. Lippincott Co., Philadelphia.

G 3. Metallurgical Laboratory Notes. H. M. Howe. Engineering and Mining Journal Co., New York.

G 4. Surface Arrangements of Reduction Works. Vol. I. International Text Book Co., Scranton, Pa.

G 5. Corporate Management. Conyngton. The Roland Press, New York.

S 2. Metallurgy of Gold, Silver, Copper, Lead and Zinc. Vol. I and II. International Text Book Co., Scranton, Pa.

S 2. Manufacture of Iron and Steel. International Text Book Co., Scranton, Pa.

S 3. Ore Dressing. R. H. Richards. Ed. of 1903. Engineering and Mining Journal Co., New York.

M. MECHANICAL ENGINEERING.

M 1 and 6. The Materials of Construction. J. B. Johnson. John Wiley & Sons, New York.

M 2. Pattern Maker's Assistant. Joshua Rose. D. Van Nostrand Co., New York.

M 2. Modern Machine Shop Tools. Vandervoort. N. W. Henley & Co., New York.

M 4. Text-Book on the Mechanics of Materials. Mansfield Merriman. John Wiley & Sons, New York.

M 4. "Cambria Steel."

M 5. The Mechanical Engineering of Power Plants. F. R. Hutton. John Wiley & Sons, New York.

M 6. Hydraulic Cement. F. P. Spaulding. John Wiley & Sons, New York.

M 9. Experimental Engineering. R. C. Carpenter. John Wiley & Sons, New York.

M 10. Pumping Machinery. W. M. Barr. J. B. Lippincott Co., Philadelphia.

M 10. Mechanical Engineer's Pocket Book. W. Kent. J. Wiley & Sons, New York.

M 14. Compressed Air and its Application. Hiscox. N. W. Henley & Co., New York.

M 15. Lettering for Draughtsmen. C. W. Reinhardt. D. Van Nostrand, New York.

M 15. Elements of Mechanical Drawing. Last Edition. G. C. Anthony. D. C. Heath & Co., Boston.

M 16. Machine Drawing. Last Edition. G. C. Anthony. D. C. Heath & Co., Boston.

N. ELECTRICAL ENGINEERING.

N 1. Incandescent Wiring Hand Book. T. B. Badt. Electrical Publishing Co., Chicago.

N 1. Electrical Engineering. Rosenberg, Gee & Kinzbrunner. J. Wiley Sons, New York.

Q. CIVIL ENGINEERING.

Q 1, 4 and 5. Theory and Practice of Surveying. Last Edition. J. B. Johnson. John Wiley & Sons, New York.

Q 1. Field Engineering. Last Edition. William H. Searle. John Wiley & Sons, New York.

Q 2 and 3. A Treatise on Hydraulics. Last Edition. Mansfield Merriman. John Wiley & Sons, New York.

Q 4 and 5. The Theory and Practice of Lettering. C. E. Sherman, Columbus, Ohio.

Q 4. A Practical System of Freehand Lettering. Charles W. Reinhardt. D. Van Nostrand Co., New York.

Q 6. Graphic Analysis of Roof Trusses. Last Edition. Charles E. Green. John Wiley & Sons, New York.

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R. MINING ENGINEERING.

R 1. A Text-Book of Ore and Stone Mining. Last Edition. C. LeNeve Foster. J. B. Lippinncott Co., Philadelphia.

R 2. Manuscript Notes on Mine Surveying and Mining. Revised, 1901. F. W. Sperr.

R 4. Manuscript Notes on Mine Engineering. Revised, 1903. F. W. Sperr.

R 5. Manuscript Notes on Mine Management and Accounts. Revised, 1903. F. W. Sperr.

S. ORE DRESSING.

S 2. Ore Dressing and Milling. International Text-Book Co., Scranton, Pa.

S 2. Sampling of Ores. International Text-Book Co., Scranton, Pa.

S 2. Ore Dressing. R. H. Richards. Edition of 1903. Engineering and Mining Journal Co., New York.

S 3. Ore Dressing. R. H. Richards. Edition of 1903. Engineering and Mining Journal Co., New York.

V. BIOLOGY.

V 2. Comparative Zoology. 1895. James Orton. Harper & Bros., New York.

V 2. A Text-Book of Palaeontology. 1900. Karl Von Zittel. Translated by Charles R. Eastman. The Macmillan Co., N. Y.

W. MINERALOGY.

W 1. Elements of Crystallography. Last Edition. G. H. Williams. H. Holt & Co., New York.

W 2. The System of Mineralogy. Sixth Edition. 1892. James D. Dana and E. S. Dana. John Wiley & Sons, New York.

X. PETROGRAPHY

X 1. Microscopical Physiography of the Rock Making Minerals. Third Edition, 1893. H. Rosenbusch. Translated by J. P. Iddings. John Wiley & Sons, New York.

Y. GEOLOGY.

Y 3. Text-Book of Geology. A. Geikie. The Macmillan Co., New York.

STUDENTS ENROLLED IN 1903-1904

Whose names do not appear in the register of students published for that year.

Bolley, William Remington,	*Eagle River.*
Crowdus, John William,	*Dallas, Texas.*
Drake, John Miller, Jr.,	*San Josè, Calif.*
Jeffs, Benjamin,	*Rockland.*
Schacht, William Henry,	*Ishpeming.*
Wood, Robert Franklin,	*Blandford, Mass.*
Wrampelmeier, Ernest Leon Swift,	*London, England.*

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REGISTER OF STUDENTS, 1904-1905

NAME	RESIDENCE
Almy, Samuel Willett,	*Altamont, Ky.*
Anderson, George Andrew,	*Detroit.*
Anderson, Milton Baird,	*Calumet.*
Andrew, Samuel George,	*Calumet.*
Andrews, Worth Briggs,	*Duluth, Minn.*
Arndt, Arthur Henry,	*Detroit.*
Austin, Charles Luther,	*Saginaw.*
Bachelder, Robert Boyd,	*Oakland, Cal.*
Baker, Albert Means,	*Yellow Springs, Ohio.*
Barabe, Clifford Aloysius,	*Houghton.*
Bennett, Thomas Herbert,	*Houghton.*
Blick, John Charles,	*Pasadena, Calif.*
Blitz, Frank,	*Detroit.*
Boelio, Louie,	*Mancelona.*
Bolley, William Bennington,	*Eagle River.*
Botsford, Charles Ward,	*Calumet.*
Bowen, Winfred Graves,	*Detroit.*
Boyce, Clarence R.,	*Binghamton, N. Y.*
Brandt, Hjalmer Andrew,	*Duluth, Minn.*
Bretherton, Wallace Bruno,	*Butte, Mont.*
Brooks, George Sage, B.S. (Michigan College of Mines),	*Milwaukee, Wis.*
Buchanan, Jerome Robinson,	*Pasadena, Calif.*
Buchman, Louis,	*Rapid River.*
Burke, Gilbert Michael,	*Canandaigua, N. Y.*
Caine, Milton Alexander,	*Lansing.*
Calkins, Frederic Ellis,	*Petoskey.*
Campbell, David Henry, Ph.G. (Massachusetts College of Pharmacy),	*Denver, Colo.*
Carroll, Thomas Patrick,	*Hancock.*
Cavan, David Brigham,	*Houghton.*
Charlton, Demetrius Edward,	*Marquette.*
Church, John Letchworth,	*Duluth, Minn.*
Churchill, Ned J.,	*Waupaca, Wis.*
Cooper, L. Dix,	*Grass Lake.*
Crowdus, John William,	*Dallas, Texas.*
Dallas, James R.,	*Pittsburg, Pa.*
Davidson, Arthur John,	*Grand Rapids.*

NAME	RESIDENCE
Dawson, Richard Trafton,	*Detroit.*
Derwin, Lewis Thomas,	*Otisville.*
De Vlieger, John Alexander,	*Grand Rapids.*
De Wilde, Felix Julius,	*Sheboygan, Wis.*
Dietz, Christian Shuman,	*Mechanicsburg, Pa.*
Dillaway, Robert Gardiner, A.B. (University of Michigan),	*Romeo.*
Dillon, Harry Thomas,	*Houghton.*
Douglass, Robert H.,	*Houghton.*
Downing, Robert Lee,	*St. Paul, Minn.*
Drake, John Miller, Jr.,	*San Josè, Calif.*
Duncan, Lawrence Grant,	*St. Joseph, Mo.*
Dykema, William P.,	*Grand Rapids.*
Edyvean, Edmund H.,	*Lake Linden.*
Eichhorn, Clarence Carl,	*Port Huron.*
Emrey, George Leitch,	*Manistee.*
Erdlitz, Joseph Frank,	*Menominee.*
Fisher, Frank Loring,	*Duluth, Minn.*
Fitch, Cecil A.,	*Beacon.*
Fitch, Howard Walter,	*Beacon.*
Fitch, Robert Smithson,	*Warrensburg, Pa.*
Fox, Arthur Christ,	*Houghton.*
Fraser, Lee,	*Saginaw.*
Freeman, Lawrence Kimball,	*Flint.*
Furbeck, John Philip,	*Oak Park, Ill.*
Gage, Walter Henry,	*Saginaw.*
Gerry, Alex Le Roy,	*Danbury, Conn.*
Getchell, Walter Charles,	*Mt. Pleasant.*
Gilbert, Isaac Leggett,	*Detroit.*
Gillett, Benjamin,	*Hubbell.*
Grabower, Chauncey Heinrich,	*Marquette.*
Graham, Ernest R.,	*Croswell.*
Graham, John Fraser,	*Detroit.*
Grant, Wilbur Henry,	*Ann Arbor.*
Green, Clarence Jasper,	*Hillsdale.*
Griffin, Fitz Roy Nicholas,	*London, England.*
Gustafson, George Harry Antoul,	*Lead, S. D.*
Haggerty, Howard,	*Detroit.*
Halter, Richard Grant,	*Chihuahua, Mex.*
Hamilton, Orr Ross,	*Denver, Colo.*
Harrison, Perry Galbraith,	*Minneapolis, Minn.*
Hartness, James Cameron,	*Marquette.*
Haug, Edward Joseph,	*Houghton.*
Heap, Robert Reginald,	*Muskegon.*
Hedges, J. Harold, B.S. (Michigan Agricultural College),	*Lansing.*
Henderson, Enoch,	*Marquette.*

NAME	RESIDENCE
Hermann, Charles Frederick,	*Calumet.*
Hill, James Madison,	*Chicago, Ill.*
Hill, Roy Nathan,	*Cass City.*
Hillenbrand, William Joseph,	*Houghton.*
Hitchcock, Clarence Horace,	*Ludington.*
Hitchcock, Frank Artemas,	*Edgerton, Wis.*
Hoar, William Bennetts, Jr.,	*Houghton.*
Holden, Edgar Freeborn,	*Muskegon.*
Holmes, J. Allison,	*Houghton.*
Horton, Albert Cary,	*Grand Rapids.*
Hotchkin, Merritt Windes,	*Chicago, Ill.*
Houston, Fred Kennedy,	*Beaver, Pa.*
Hovland, Joseph T.,	*Zumbrota, Minn.*
Hunt, Robert Courtney,	*Houghton.*
Huston, Milton Benjamin,	*Ypsilanti.*
Ives, Lee Emmett,	*Minneapolis, Minn.*
Jackman, Herbert Everard, Ph.B. (Syracuse University),	*East Jordan.*
Jefferson, Harry Edward Curzon,	*Houghton.*
Jones, Edward Raymond,	*Minneapolis, Minn.*
Kanter, Frank W.,	*Detroit.*
Kelly, Charles Brace,	*Grand Rapids.*
Kelley, Frank Arthur,	*Minneapolis, Minn.*
Kelsey, Newton Standish,	*San Francisco, Cal.*
Kester, Robert Livingston,	*Philadelphia, Pa.*
Kimball, Eugene Delroy,	*Minneapolis, Minn.*
King, Carl Benton,	*Hancock.*
King, Edward Charles,	*Houghton.*
Kingston, Carl John,	*Calumet.*
Klinglund, Frank David,	*Sault Ste. Marie.*
Kruse, Henry John,	*Beacon.*
Kuntz, Julius Matthew,	*Freda.*
Langley, Clifton Evans,	*Detroit.*
Langworthy, William Probasco,	*Houghton.*
Lavery, Vaughan Metcalfe,	*Evanston, Ill.*
Lewis, Charles Hobart,	*Milwaukee, Wis.*
Lewis, William Frank,	*Kenton.*
Lindberg, Carl Otto,	*Houghton.*
Linn, Alick Erland,	*Norway.*
Linton, Lawrence Lowry,	*Saginaw.*
Linton, Raymond Aaron,	*Saginaw.*
Little, Marcus Charles Herbert,	*London, England.*
Longan, Walker Bowles,	*Kansas City, Mo.*
Longshore, Rudolph Peirce,	*Sheldon, Iowa.*
McCollom, Charles Rolfe,	*Minneapolis, Minn.*
McCormac, Thomas,	*Tombstone, Ariz.*
McIntire, Robert,	*Helena, Mont.*

NAME	RESIDENCE
MacKillican, James Angus,	*Escanaba.*
McLaughlin, Warren John,	*Iron Mountain.*
McLeod, Roderick Carlyle,	*Milwaukee, Wis.*
Mailhot, Charles Moise,	*Houghton.*
Maitland, Harvey Keith,	*Negaunee.*
Maitland, Leslie Mackenzie,	*Negaunee.*
Manly, Aden J.,	*Deerfield.*
Marshall, George Bowen,	*New York, N. Y.*
Mathews, Abe, Jr.,	*Marquette.*
Meek, Harry Calvin,	*Manton.*
Merry, Henry Monroe,	*Low Moor, Va.*
Meuche, Alfred Hermann,	*Dayton, Ohio.*
Mitchell, James Macdonald, A.B. (Columbia College),	*Flushing, N. Y.*
Muir, Neal Matthew,	*St. Paul, Minn.*
Myers, Albert John,	*Phoenix.*
Myers, Elmer A., A.B. (University of Michigan),	*Greenville.*
Netzorg, Leon,	*Detroit.*
Nichols, Henry William,	*Evanston, Ill.*
Palmer, Russell Burruss,	*Saginaw, W. S.*
Parkhurst, Frederick Shrewsbury, Jr., B.S. (Michigan College of Mines),	*Medina, N. Y.*
Pattison, William Brooks,	*Kalamazoo.*
Pearce, Edward,	*Negaunee.*
Pearce, Lewis Frederick, Jr.,	*Negaunee.*
Penberthy, Ira Gladstone,	*Calumet.*
Perry, Joseph Bond,	*Joliet, Ill.*
Phillips, Robert Bailey,	*El Paso, Texas.*
Pittman, Clarence Dane,	*Hancock.*
Pohle, Louis Herman,	*Seattle, Wash.*
Pomeroy, Ralph Eugene Henry,	*Chicago, Ill.*
Potter, Ocha,	*Trimountain.*
Powell, Samuel, Jr.,	*Chicago, Ill.*
Presho, Edward Webb, B.A. (Tufts College),	*Los Angeles, Cal.*
Quinn, Clement Kruse,	*Beacon.*
Randolph, George Oscar,	*Marquette.*
Raymond, George Joseph,	*Grand Rapids.*
Redner, Arthur Edmund,	*Bessemer.*
Reis, Harold Charles,	*Edinburgh, Scotland.*
Reynolds, Frank Arthur,	*Detroit.*
Reynolds, George Osmar, Jr.,	*Pelham Manor, N. Y.*
Rice, Eugene Roche, B.S. (Agricultural and Mechanical College of Texas),	*Kalamazoo.*
Roberts, William H.,	*Painesdale.*

[redacted]

NAME	RESIDENCE
Roe, Ira Smith,	*Detroit.*
Rork, Frank Curtis, B.S. (Michigan Agricultural College),	*Lansing.*
Rose, Arthur Herbert,	*Evart.*
Rough, Albert James,	*Negaunee.*
Royce, Frederick,	*Hancock.*
Rumsey, Edward Prole,	*Batavia, N. Y.*
Saam, Louis August,	*Hancock.*
Satterly, Joseph,	*Hubbell.*
Scallon, Edward Philip,	*Hancock.*
Schacht, William Henry,	*Milwaukee, Wis.*
Schaus, Oliver Montell,	*Milwaukee, Wis.*
Schubert, George,	*Hancock.*
Schuffert, Abraham Lincoln,	*Wyandotte.*
Seaman, Wyllys Arthur,	*Houghton.*
Segsworth, Walter Edgar,	*Toronto, Ont., Can.*
Seifert, John A.,	*Hancock.*
Sharp, Harry,	*Houghton.*
Shotwell, Herbert Clarence.	*Detroit.*
Sipprell, James Garfield, B.A. (Acadia College),	*St. John, N. B.*
Slaughter, William Frost,	*Escanaba.*
Smith, Alfred Leggatt,	*Pontiac.*
Smith, Carson Willard,	*Duluth, Minn.*
Sparks, Benjamin Franklin,	*Grand Rapids.*
Stadler, George Herman,	*Detroit.*
Stakel, Charles Joseph,	*Menominee.*
Steinbach, Harry Philip,	*L'Anse.*
Steinem, Chester,	*Toledo, O.*
Stemmer, Joseph Herman,	*Hancock.*
Sumner, George Howard,	*Detroit.*
Sweeney, Wilfred Gray,	*Duluth, Minn.*
Tate, John Humphreys,	*Kansas City, Mo.*
Tietsort, Roy Abram,	*Detroit.*
Torbert, James Burnett,	*Jersey Shore, Pa.*
Tregoning, Richard Alfred,	*Hubbell.*
Tuttle, Horace Burt, Ph.B. (Sheffield Scientific School),	*Euclid, O.*
Van Bergen, Robert Evans,	*Minneapolis, Minn.*
Van Evera, James Wilbur,	*Marquette.*
Van Slyke, William Ralph,	*Detroit.*
Vivian, Harry,	*Calumet.*
Waara, Jacob William,	*Hancock.*
Wagner, John Ezra,	*Belding.*
Walker, Marshall Starr,	*Grand Rapids.*
Wallace, William John,	*Houghton.*
White, George James,	*Pontiac.*

NAME	RESIDENCE
Wilcox, Thomas Henry,	*Ontonagon.*
Wilkinson, Paul Harris,	*Crookston, Minn.*
Williams, Harrison Gaylord, A.B. (University of Michigan),	*Lapeer.*
Williams, Jerome Joseph,	*Chicago, Ill.*
Williams, Leslie Allers,	*Saginaw.*
Williamson, Francis Olsaver,	*Milwaukee, Wis.*
Wilson, Frank Brown,	*Stamford, Conn.*
Wood, Robert Franklin,	*Blandford, Mass.*
Woodworth, Irwell Newton,	*Grand Rapids.*
Wright, Howard Gregory,	*Hancock.*
Yates, Edwin Fish,	*Chicago, Ill.*

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SUMMARY OF STUDENTS, 1904-1905

BY STATES AND COUNTRIES.

Arizona	1
California	6
Canada	2
Colorado	2
Connecticut	2
England	2
Illinois	10
Iowa	1
Kentucky	1
Massachusetts	1
Mexico	1
Michigan { Upper, 74 / Lower, 66 }	140
Minnesota	17
Missouri	3
Montana	2
New York	7
Ohio	4
Pennsylvania	6
Scotland	1
South Dakota	1
Texas	2
Virginia	1
Washington	1
Wisconsin	9
Total	223

Average Age of Students, 1904-05 .... 22½ years

[redacted]

SUMMARY OF ENROLLMENT DURING EXISTENCE OF THE COLLEGE

The number of new students who entered, the total enrollment, and the number of graduates sent out for each year of the existence of the College, are as follows:

Year	86–7	87–8	88–9	89–90	90–1	91–2	92–3	93–4	94–5	95–6	96–7	97–8	98–9	99–00	1900–01	1901–02	1902–03	1903–04	1904–05
New students	23	15	16	15	46	40	45	17	49	43	82	83	42	54	71	95	92	101	99
Total attendance	23	29	40	35	61	78	101	82	94	94	140	122	116	121	146	197	221	238	223
Graduates	..	7	6	5	4	0	8	17	22	18	5	18	24	19	25	24	42	41	...

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RECORD OF GRADUATES

The College issues a Record of Graduates, a booklet which gives as accurately as possible the various positions held by graduates up to and including the Class of 1903.

Below is given a record of the Class of 1904, so far as in possession of the College:

Adams, Clement Lawerson, B.S., 1904.
Chemist, Copper Range Consolidated Mining Co.
Freda, via Houghton, Mich.

Anderson, Robert Hutchison, B.S., E.M., 1904.
Sampler, Cerro de Pasco Mining Co. Prospector, Cerro de Pasco Mining Co., Cerro de Pasco, Peru. Bookkeeper, Tullis & Co., Ltd., Edinburgh, Scot. Sampler, May Consolidated Gold Mining Co., Ltd., Transvaal, S. A. Assistant Surveyor, May Consolidated Gold Mining Co., Ltd., Transvaal, S. A.
Box 50, Germiston, Transvaal, S. A.

Bailey, Marc, B.S., E.M., 1904.
Mining Engineer. Chanute, Kan.

Bauder, William Ralph, E.M., 1904.
With Horn Silver Mining Co. and Centrifugal Separating Co., Frisco, Utah. Mining Engineer, Chicago, Ill.
6410 Harvard Ave., Chicago, Ill.

Brooks, George Sage, B.S., 1904.
Assistant in Mining Engineering, Michigan College of Mines. With Empire Mining Co., Platteville, Wis.
Platteville, Wis.

Caulfield, John J., Jr., B.S., E.M., 1904.
Manager of the Michigan Sand & Gravel Co., Grand Rapids, Mich. 110 Sheldon St., Grand Rapids.

Chope, William Edward, B.S., E.M., 1904.
With the Frances J. Hobson Company, Mining and Metallurgical Engineers. Apartado 25, Guanajuato, Mex.

Cram, Frederick William, E.M., 1904:
Miner, Calumet and Hecla Mining Co., Calumet. Chemist and Engineer, Commonwealth Iron Co., Commonwealth, Wis. Commonwealth, Wis.

Deane, Willard Albert, E.M., 1904.
Assistant Mining Engineer, Ciero Prieto Mining Co., Sonora, Mex. Sonora, Mex.

Devine, Henry Edward, B.S., E.M., 1904.
Assistant Engineer; with Lake Superior Iron Company. Ishpeming, Mich.

Dodge, Charles Warren, Jr., B.S., 1904.
Assistant, U. S. Geol. Survey, Alaska; Assistant Engineer, Bingham Consolidated Mining & Smelting Co., Salt Lake City; Assayer, San Juan Ore Co., Rico, Colo.; Engineer, Durango, Colo. Box 200, Durango, Colo.

Donahoe, Frank Timothy, E.M., 1904.
Engineer and Chemist, Sunday Lake Iron Co. and Brotherton Iron Mining Co., Wakefield, Mich.; Practical Miner, Bell Mine, Butte, Mont. 107½ W. Quartz St., Butte, Mont.

Drew, Charles Verner, (S.B., University of Chicago), E.M., 1904.
Assistant to Chief Engineer in office of Frank Klepetko, Consulting Engineer. 307 Battery Park Bldg., New York, N. Y.

Fink, William Nelson, B.S., E.M., 1904.
Reporting on the Mines and Smelter of the Wisconsin-Mexico Mining Co., Huepac, Sonora, Mex.; Shiftboss, Henrietta Mine, Cananea Consolidated Copper Co., La Cananea, Sonora, Mex.; Miner, Black Pearl Mine, Pearl, Idaho; Superintendent of Concentrator, and Assayer, Highland Gold Mining Co., Haines, Ore.; Superintendent, Highland Gold Mining Co., Haines, Ore.; Mining Engineer, Niblack Copper Co., Niblack, Alaska. Niblack, Prince of Wales Isle, Alaska.

Gallagher, John Hubert, E.M., 1904.
Engineer, with the Hammond Mfg. Co., Incorporated, Portland, Ore. Portland, Ore.

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Garrey, George Henry, E.M., 1904.
Mining Geologist, United States Geological Survey.
Room 331 U. S. Geological Survey Bldg., Washington, D. C.

Gates, Charles Cassius, E.M., 1904.
Engineer and Chemist, West Gold Hill Mining Co.; Superintendent of Cyanide Mill, West Gold Hill Mining Co.; General Superintendent Mine and Mill, West Gold Hill Mining Co., Tin Cup, Colo. Tin Cup, Colo.

Goodman, Francis Benjamin, B.S., E.M., 1904.
Laborer, Bingham Consolidated Mining & Smelting Co.'s Smelter; Assistant Engineer, Bingham Consolidated Mining and Smelting Co., Bingham Junction, Utah; Engineer, Mexico Consolidated Mining & Smelting Co., Guanacevi, Mex. Guanacevi, Durango, Mex.

Gordon, William Crosgrove, B.S., 1903, E.M., 1904.
Geologist, Michigan Geological Survey. Houghton.

Johnson, John Saras, B.S., E.M., 1904.
Cyanide man for the American Copper Co. at the Iron King Mines, Blanchard, A. T.; Assayer and Draughtsman with the Clark Engineering Co., Bisbee, A. T.; Chemist for the Cyanide Plant and Engineer with Swatling & Smith, Commonwealth Mine, Pearce, Ariz. Pearce, Ariz.

Johnson, Ralph Browning, E.M., 1904.
Draughtsman, Hodge Iron Company, Hancock. Houghton.

Jordan, Fred Allen, B.S., E.M., 1904.
Instructor in Department of Mathematics and Physics, Michigan College of Mines.

Lang, Sidney Sherman, B.S., E.M., 1904.
Engineer, Burro Mountain Copper Co., Leopold, N. M.
Leopold, via Silver City, N. Mex.

Lockhart, Carl Brown, B.S., E.M., 1904.
Assistant Assayer, The San Juan Ore Company, Rico, Colo.; Auditor and Assayer, The San Juan Ore Company, Rico, Colo. Rico, Colo.

Marshall, Cyrus Buxton, B.S., E.M., 1904.
With the Sheba Mining Co., Mett City, Nev. Mett City, Nev.

Maxwell, Harry West, B.S., E.M., 1904.
Engineer, St. Anthony Consolidated Mining & Milling Co., Alamo, Ore. 365 Ashland Bldg., Chicago, Ill.

Morrison, George Adelbert, B.S., E.M., 1904.
With the Portland Gold Mining Co., Victor, Colo.; with Hills & Willis, Mining Engineers and U. S. Deputy Mineral Surveyors, Cripple Creek, Colo. Cripple Creek, Colo.

Norton, James Thomas, B.S., 1903, E.M., 1904.
Surveyor, Great Northern R. R., N. Dak. Devil's Lake, N. Dak.

Oliver, Robert Sheldon, B.S., 1903, E.M., 1904.
Draughtsman, The Lake Superior Smelting Co., Dollar Bay, Mich.; Assistant Mining Engineer, The Trimountain Mining Co., Trimountain, Mich.; Assayer and Chemist, The Continental Alta Mines. Alta, Utah.

Parkhurst, Frederick Shrewsbury, Jr., B.S., 1904.
Mining Engineer, Winona Copper Co., Winona, Mich.; Assistant Engineer, Municipal Water Works, Medina, N. Y. Medina, N. Y.

Pascoe, William, B.S., E.M., 1904.
Mining Engineer and Chemist, Chiricahua Development Co., Paradise, Ariz.; Engineer, Crete Mining Co., Hibbing, Minn. Hibbing, Minn.

Rakowsky, Victor Hugo, E.M., 1904.
Engineer and Chemist, with Illinois Iron Mining Co., Baraboo, Wis. North Freedom, Wis.

Robinson, Glen, B.S., E.M., 1904.
Assayer, Adventure Consolidated Copper Co., Redridge; Assistant Engineer, Tamarack & Osceola Consolidated Mining Companies, Calumet. Calumet.

St. Clair, William Rood, B.S., E.M., 1904.
Mechanical Draughtsman, Lake Superior Smelting Co., Dollar Bay; Mining Engineer, Stearns Coal Co., Ltd., Stearns, Ky.; Mining Engineer, Breitung Haematite and Mary Charlotte Mines, Negaunee. Ishpeming, Mich.

Salisbury, Earl Fremont, E.M., 1904.
Engineer, Eva Gold Mines, Ltd., Camborne, B. C.; Assistant Engineer, Mazapil Copper Co., Ltd., Concepcion del Oro, Zac. Mex. Concepcion del Oro, Zacatelcas, Mex.

Siau, Robert Holmes, E.M., 1904.
In charge of Siau Laundry. 345 Woodward Ave., Detroit, Mich.

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Soddy, Francis Joseph, B.S., 1903, E.M., 1904.
Mining Engineer, Calumet, Mich. Calumet

Steubing, William Colson, E.M., 1904.
Engineering Practice, Louisville, Ky.
430 E. St. Catherine, Louisville, Ky.

Stewart, Jesse Arthur, B.S., E.M., 1904.
With the Shannon Copper Co., Metcalf, Ariz. Metcalf, Ariz.

Story, Ralph Whitney, (B.A., Beloit College), B.S., E.M., 1904.
Surveyor and Draughtsman with Clark Engineering Co., Bisbee, Ariz.; Surveyor and Draughtsman with City Engineer, Bisbee, Ariz. Bisbee, Ariz.

Sumner, George Howard, B.S., E.M., 1904.
Assistant in Mechanical Engineering, Michigan College of Mines. With La Mina Santo Tomas de Villa Neuva, Estacion Ahorcado, Queretaro, Mex.
Estacion, Ahorcado, State of Queretaro, Mex.

Thomas, Philip Porter, E.M., 1904.
Howard Thomas & Philip P. Thomas, General Engineering, Duluth, Minn., and Superior, Wis. Superior, Wis.

Turner, Scott, B.S., E.M., 1904.
With the Tombstone Consolidated Mines Co., Ltd.
Tombstone, Ariz.

Walker, Myron Reed, B.S., E.M., 1904.
Surveyor, Tamarack Mining Co., Calumet; Draftsman and Designer, Michigan Smelting Co., Coles Creek; Mining Engineer, Mazapil Copper Co., Ltd., Concepcion del Oro, Zac. Mexico. Concepcion del Oro, Zacatecas, Mex.

Wheeler, Zenas Frank, B.S., 1903, E.M., 1904.
With North American Copper Co., Grand Encampment, Wyo.; Foreman, Concentrating Mill, Emma Mining Co., Tuscarora, Nev. Tuscarora, Nev.

Williams, John Prydderch, Jr., B.S., 1903, E.M., 1904.
Assistant in Department of Civil and Mining Engineering, Michigan College of Mines, Houghton; Sampler, Calumet and Arizona Mining Co., Bisbee, Ariz.; Inspector of Development Work and Geologist, Calumet and Arizona Mining Co. Bisbee, Ariz.

Williams, Percival Sherman, B.S., E.M., 1904.
Timberman, Dalton and Lark Mine, Bingham Canyon, Utah; Chemist and Assayer, Eagle and Blue Bell Mine; Chief Mining Engineer, Bingham Consolidated Mining and Smelting Co., Lark, Utah. Lark, Utah.

Wright, Louis Aldro, B.S., E.M., 1904.
Mining Engineer for Francisco Armendaiz, Monterey, N. L., Mex.; Cerralvo, N. L., Mex.; Sierra Mojada, Coahuila, Mex.; Mapimi, Durango, Mex.; Superintendent of La Luz Mine, Cuatro Cienegas, Coahuila, Mex.; Consulting Engineer for Compañia Minera, Fundidora y Afinadora de Monterey, Monterey, N. L., Mex.; Examining Engineer and Superintendent in Mexico for J. Parke Channing and Lewisohn Brothers, New York; General Superintendent of Mines for Compañia Metalurgica Mexicana, Sierra Mojada, Coahuila, Mex.; Assistant General Superintendent of The Sombrerete Mining Company, Sombrerete, Zacatecas, Mex.; Acting General Superintendent of The Sombrerete Mining Company, Sombrerete, Zacatecas, Mex.; Mining Engineer, general practice, office, El Paso and San Antonio, Tex. San Antonio, Tex.

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HOUGHTON
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QUINCY
FRANKLIN
MINERAL
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DISTRICT
Mines Catalogue

Explanation of Tables and Maps

TABLES

Table I shows the term or terms in which each subject is taught, its proportionate credit in tenths of a unit, the number of times each week that the student must appear in class-room for recitation or lecture, and the total number of hours each week an average student is expected to put upon the subject. This total includes both laboratory and study time with the class-room time. The time spent at the College includes both the recitation and laboratory hours.

Tables II, III, IV, and V show the particular hours in each week at which the student taking a given subject meets the instructor in the class-room for recitation or lecture.

These tables do not show the laboratory hours, which must be arranged with the instructors having charge of the work. These may differ widely for different students.

In choosing his subjects for any year the student must avoid conflicts; that is, he must not choose two subjects which have a common recitation or lecture period.

No hour table is given for the practice courses of the summer term, the practice work in Mine Surveying and Mining (R 3), nor the excursions to the mines, mills and field in the courses R 1 (Principles of Mining), G 2 (Metallurgy), M 11 (Mechanical Engineering II.) and Y 1 (Principles of Geology). While pursuing any one of the practice courses the student devotes to it his whole time. The excursions in the other courses are arranged for while the courses are in progress. Therefore no hour tables are necessary.

MAPS

To make clear the fact of the location of the College of Mines in the midst of active mining operations, two maps are shown.

The first gives a detailed exhibit of the Portage Lake Minin District, which forms the immediate vicinity of the College. Mos of the active copper mines within the territory covered by this ma are indicated on it.

The second is a general map of the mineral districts of tl Upper Peninsula. It shows the various iron and copper rang which are accessible from the College. No attempt has been ma to indicate the different mining districts of the Copper Range, n the subdivisions of the Iron Ranges.

erm, 1906

FRIDAY.	SATURDAY.
4. Analytic Geometry, Sec's 1 and 2. 5. Calculus, Sec. 1. 1. Analytic Mechanics, Sec. 1. 4. Mining Engineering.	A 5. Calculus, Sec. 1. G 3. Metallurgical Laboratory Practice. M 4. Mechanics of Materials, Sec. 1. N 1. Electrical Engineering.
5. Calculus, Sec's 2 and 3. 1. Analytic Mechanics, Sec. 2. 7. Quantitative Analysis, Sec. 1. 1. Principles of Mining, Sec. 3.	A 1. Algebra, Sec. 1. A 5. Calculus, Sec's 2 and 3. G 6. Metallurgical Accounts. M 4. Mechanics of Materials, Sec. 2.
1. Analytic Mechanics, Sec. 3. 16. Machine Drawing, Sec. 1. 5. Mine Management and Accounts. 1. Principles of Geology.	A 1. Algebra, Sec's 2 and 3. A 5. Calculus, Sec. 4. M 3. Design of Structural Joints. Q 2. Hydraulics, Sec. 1.
4. Analytic Geometry, Sec's 3 and 4. 5. Calculus, Sec. 4. 2. Historical Geology.	A 1. Algebra, Sec. 4. F 3. Qualitative Analysis, Sec. 1. M 4. Mechanics of Materials, Sec. 3. Y 5. Economic Geology.
1. Physics. 16. Machine Drawing, Sec. 2. 7. Engineering Design and Construction.	M 1. Properties of Materials, Sec. 1. Q 2. Hydraulics, Sec. 2. X 1. Petrography.
7. Quantitative Analysis, Sec. 2. 2. Metallurgy, Sec. 1. 2. Mineralogy.	M 1. Properties of Materials, Sec. 2.
3. Electrical Measurements. 1. General Chemistry, Sec's 1, 2, 3 and 4. 2. Mine Surveying and Mining. 3. Physical and Chemical Geology.	Q 2. Hydraulics, Sec. 3.
3. Qualitative Analysis, Sec. 3. 2. Metallurgy, Sec. 2. 1. Principles of Mining, Sec. 4.	
3. Qualitative Analysis, Sec. 2. 16. Machine Drawing, Sec. 3. 1. Properties of Materials, Sec. 3.	

Schedule: Winter

HOURS
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10
11
12
1
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Spring Term, 1906

FRIDAY.	SATURDAY.
4. Analytic Geometry, Sec's 1, 5. Calculus, Sec. 1. [and 2. 1. Analytic Mechanics, Sec. 1. 4. Mining Engineering.	M 11. Mechanical Engineering. II, [Sec. 1.
5. Calculus, Sec's 2 and 3. 1. Analytic Mechanics, Sec. 2. 7. Quantitative Analysis, Sec. 1. 1. Principles of Mining, Sec. 3.	A 1. Algebra. Sec. 1. G 6. Metallurgical Accounts.
1. Analytic Mechanics, Sec. 3. 5. Mine Management and Ac- [counts. 1. Principles of Geology.	A 1. Algebra, Sec's 2 and 3. Q 2. Hydraulics, Sec. 1.
4. Analytic Geometry. Sec's 3 5. Calculus, Sec. 4. [and 4. 2. Historical Geology.	A 1. Algebra, Sec. 4. F 3. Qualitative Analysis, Sec. 1. Y 5. Economic Geology.
1. Physics. 7. Engineering Design and Con- [struction.	Q 2. Hydraulics, Sec. 2. X 1. Petrography.
1. General Chemistry, Sec's 1, [2, 3 and 4. 2. Metallurgy. Sec. 1. 13. Mechanical Engineering. IV. 2. Mineralogy.	M 11. Mechanical Engineering, II. [Sec. 2 X 2. Advanced Petrography.
14. Air Compression and Air [Machinery. 2. Mine Surveying and Mining. 3. Physical and Chemical [Geology.	B 3. Electrical Measurements. Q 2. Hydraulics. Sec. 3.
3. Qualitative Analysis, Sec. 3. 2. Metallurgy. Sec. 2. 1. Principles of Mining. Sec. 4.	M 11. Mechanical Engineering. II, [Sec. 3.
3. Qualitative Analysis, Sec. 2. 7. Quantitative Analysis. Sec. 2.	

YEAR BOOK

OF THE

chigan College of Mines

1905-1906

ANNOUNCEMENT OF COURSES FOR 1906-1907

HOUGHTON, MICHIGAN

PUBLISHED BY THE COLLEGE
JUNE, 1906

[redacted]

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1906

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MAY

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JUNE

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JULY

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OCTOBER

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NOVEMBER

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DECEMBER

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JANUARY

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FEBRUARY

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Calendar, 1906-1907

Fall Term begins Friday morning, September 28, 1906, and ends Friday noon, December 21, 1906—twelve weeks.

Examinations for admission and advanced standing begin Friday morning at 9 o'clock and continue through Friday and Saturday.

Regular work for all classes begins Monday, October 1, 1906, at 8 a. m. Full work is to be taken up at this time.

Thanksgiving Recess from Wednesday noon, November 29, until Monday morning, December 3, 1906.

Winter Term begins Monday morning, January 7, and ends Friday noon, March 23, 1907—eleven weeks.

Spring Term begins Monday morning, April 1, and ends Saturday evening, June 8, 1907—ten weeks.

Summer Term begins Monday morning, June 10, 1907, and ends Friday evening, August 30, 1907—twelve weeks.

Practical work in Mine Surveying and Mining begins Monday morning, May 6, and ends Friday evening, June 7, 1907.

Surveying begins Monday morning, June 10, and ends Thursday evening, August 29, 1907.

Shop Practice begins Monday morning, June 10, and ends Thursday evening, August 29, 1907.

Mechanical Laboratory Practice begins Monday morning, June 10, and ends Friday evening, July 19, 1907.

Practice work in Metallurgy begins Monday morning, June 10, and ends Friday evening, June 28, 1907.

Practice work in Ore Dressing begins Monday morning, July 1, and ends Friday evening, July 19, 1907.

Field Geology, Electrical Engineering Laboratory and Testing Materials of Engineering begin Monday morning, July 22, and end Thursday evening, *August 29, 1907.*

A Record of Graduates up to and including the class of 1905, giving their occupations, is published separately and will be sent upon request.

Michigan College of Mines

GENERAL STATEMENT

The Michigan College of Mines was established by an Act of the Legislature of 1885. The Act was entitled: "An Act to establish and regulate a Mining School in the Upper Peninsula." The Act vests the government of the institution in a Board of Control of six members appointed by the Governor of the State, by and with the consent of the Senate. Two members of the Board are appointed each alternate year to serve six years.

Sec. 5 of this Act provides that: "The course of instruction shall embrace geology, mineralogy, chemistry, mining, and mining engineering, and such other branches of practical and theoretical knowledge as will, in the opinion of the board conduce to the end of enabling the students of said institution to obtain a full knowledge of the science, art, and practice of mining, and the application of machinery thereto."

The school was opened for the reception of students September 15, 1886. Its establishment and the earlier appropriations for it are to a very large extent due to the great interest, the foresight and the energy displayed on its behalf by the late Jay A. Hubbell, of Houghton. He donated a portion of the site occupied by the College, and during his life spared no effort to further its aims or to help it toward prosperity.

Most of the students of the College have been from Michigan, since it is a Michigan institution, but it has trained men from all parts of the United States, and from a number of foreign countries in both hemispheres.

The concentration of effort on training men for the field of mining, the location of the College in a district where its students live in a mining atmosphere, together with its special methods of instruction, and manner of using the mining environment, have brought to the institution a large measure of success.

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The College was established for, and exists only for the purpose of training men to take an active part in the development of the mineral wealth of the state and nation. This concentration of effort on a particular line of training has its advantages. Many of the perplexing problems which arise where numerous lines of effort must be simultaneously proceeding are unknown in this institution. Here all work for a common object. Every employee has his share in whatever of success the College attains. This condition develops a spirit of harmonious endeavor which facilitates greatly the work of instruction.

The College has been particularly fortunate in the matter of its location. It is plain that an engineering school must derive immense advantage from a location in which its immediate surroundings continually illustrate and enforce the principles which it teaches. When the line of operations for which it is training its students is the dominant one of the region, obviously the advantage is greatest. Then the environment, even without effort on the part of the school, must serve as an efficient aid to the instruction. If those in control of these operations are in sympathy with the institution—are ready to place plants under their charge at its service for instruction, and if the institution makes wise use of opportunities thus afforded, these plants become truly a part of its equipment, and the environment then becomes a factor which must increase the efficiency of the instruction by an amount hardly to be overestimated.

The location of the Michigan College of Mines presents in a marked degree all these features. It is situated in the heart of the great copper mining region of Lake Superior.* Within a radius of eleven miles from its site are some fifteen active copper mines. Several of the largest, most extensively equipped, and most successful metal mines in the world are among them. The deepest shafts in the world and the most powerful machinery employed in mining are here in constant operation.

Besides the plants at the mines there are necessary docks, railroads, mills and smelters. To all the student has access, and he is required, under the direction and supervision of his instructors, to visit and inspect these plants and their operation at proper times during his study here. By being in such a district and being required

*See map at end of year-book.

[redacted]

to use its opportunities as he is, the student breathes from his arrival an atmosphere in entire harmony with his present and future work. He is continually inspired by observation of and contact with men who have achieved success in the line for which he is training. This location, together with the practical methods of training employed, account for the remarkable fact that of 328 men graduated up to this time, but seven have left engineering for other pursuits.

The methods of instruction include the ordinary lecture, text-book and recitation work, supplemented in every department by problems drawn as far as possible from actual practice. Because the successful engineer must be a man whose judgment of *things* is well developed, laboratory methods of instruction are given great prominence. These include the trips and laboratory courses in which the student works with his own hands rather than watches the operations of some one else. The trips of inspection are to plants which exemplify often on a large scale the application of principles taught in the classroom to problems of commercial operation. The study of such application serves to vivify the teaching and brings to the student a clearer comprehension and firmer grasp of the subject in hand. But it is obvious that in the attempt to apply the principle to some concrete problem of practice, the student will most speedily gain a true comprehension of its bearing and force. He should therefore have as far as possible his practice in the field or in properly directed laboratories. This the College endeavors to give.

Necessarily the nearer the field or laboratory practice is made to conform to the requirements of actual operation, the more forcible its teachings and the more valuable the experience here gained. This point is attended to in the various practice courses given at this institution. Moreover in such practice properly directed, lies the chief resource of the College in its effort to stimulate and influence the development of judgment on the part of the student. Under the proper sub-heads in the section of the year-book devoted to "Departments of Instruction," and in the section headed "Buildings," will be found a more detailed description of the means possessed by the College for instruction in field and laboratory, as well as a more particular account of the manner of using the several parts of the equipment and the various features of the surroundings for the purpose of giving engineering training.

The field of mining engineering is so broad, and the number of subjects bearing on it so great, that no student can profitably cover all of the ground in the time usually given to a college course. Moreover, the average student possesses greater aptitude in some part or parts of this broad field than in others. If he cannot train for all of it his chances of success are manifestly greater if he devotes himself to those portions for which he is best adapted. In order that he may do this, some way must be provided whereby different students may pursue different curriculums. To meet these conditions the Michigan College of Mines has put into operation a flexible system allowing considerable range in selecting the courses or subjects which shall compose a particular student's curriculum. This does not mean that haphazzard selection is allowed. A student desiring to pursue a certain line of work selects courses leading up to it, laying first a solid foundation. He is obliged to preserve the natural sequence of subjects. Having shown his bent and set out to train in accordance with it, he follows an orderly system of selection which may become more and more specialized as he nears the end of his course. This College was the first, and until very recently the only institution to offer such privileges of choice to a student of engineering. Regulations governing the choice of courses under this system are given with other regulations of the College on a subsequent page.

The methods outlined above have not been carelessly thought out nor hastily adopted. They have developed slowly in the earnest effort of those interested in, and responsible for the institution, to solve the problems presented to it, and to build up an efficient system of training mining engineers. Up to the present time they have stood the test of use very satisfactorily.

BOARD OF CONTROL OF THE MICHIGAN COLLEGE OF MINES

	TERM EXPIRES
Hon. John Monroe Longyear, Marquette,	June 9, 1907
Norman Washington Haire, Houghton,	June 9, 1907
William Kelly, Vulcan,	June 9, 1909
James MacNaughton, Calumet,	June 9, 1909
Murray Morris Duncan, Ishpeming,	June 9, 1911
Lucius Lee Hubbard,	June 9, 1911

Chairman of the Board of Control, - - - WILLIAM KELLY

Secretary of the Board of Control, - - FRED WALTER MCNAIR

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OFFICERS OF ADMINISTRATION

President, - - - - - - - Fred Walter McNair

Secretary and Librarian, - - - - Frances Hanna Scott

Treasurer, - - - - - - Frederick William Nichols

Superintendent of Grounds, - - Frederick William Sperr

Superintendent of Buildings, - - - Ozni Porter Hood

STAFF OF INSTRUCTION

FRED WALTER McNAIR, B.S. (University of Wisconsin), President.

GEORGE AUGUSTUS KOENIG, M.E. (Polytechnikum, Karlsruhe), A.M., PH.D. (University of Heidelberg), Professor of Chemistry.

FREDERICK WILLIAM SPERR, E.M. (Ohio State University), Professor of Civil and Mining Engineering.

OZNI PORTER HOOD, M.S., M.E. (Rose Polytechnic Institute), Professor of Mechanical and Electrical Engineering.

ARTHUR EDMUND SEAMAN, B.S. (Michigan College of Mines), Professor of Mineralogy and Geology.

JAMES FISHER, JR., E.M. (Michigan College of Mines), Professor of Mathematics and Physics.

LEONARD STRONG AUSTIN, PH.B. (Yale University), Professor of Metallurgy and Ore Dressing.

ELMER DANIEL GRANT, B.A. (Colgate University), M.A. (University of Chicago), Assistant Professor of Mathematics and Physics.

GEORGE LUTHER CHRISTENSEN, B.S. (Kansas State Agricultural College), Assistant Professor of Mechanical Engineering.

MRS. FRANCES HANNA SCOTT, Librarian and Secretary.

FREDERICK ABRAHAM DELAY, B.S. (University of Wisconsin), Instructor in Mechanical and Electrical Engineering.

GEORGE WATSON COREY, B.S. (Michigan College of Mines), Instructor in Mineralogy and Geology.

JOHN CENTENNIAL McGRATH, B.S., M.E. (Purdue University), Instructor in Machine Shop.

GUSTAVE FERNEKES, B.S., PH.D. (University of Wisconsin), Instructor in Chemistry.

CHARLES EDMUND HAIGLER, B.S. (Ohio State University), Instructor in Mathematics and Physics.

CLEMENT EUGENE ROOD, PH.B., PH.M. (Albion College), Instructor in Mathematics and Physics.

CHARLES GAMBLE SIMPSON, M.A. (Cornell College), Instructor in Mathematics and Physics.

FRED ALLEN JORDAN, B.S., E.M. (Michigan College of Mines), Instructor in Mathematics and Physics.

ARTHUR ALEXANDER KOCH, M.S. (University of Wisconsin), PH.D. (University of Basel), Instructor in Chemistry.

CHARLES FRANKLIN BOWEN, B.S., B.Y. (College of Utah), M.S. (University of Wisconsin), Instructor in Geology and Mineralogy.

EUGENE THOMAS HANCOCK, B.S. (University of Wisconsin), Instructor in Mineralogy.

DURWARD COPELAND, B.S. (Massachusetts Institute of Technology), Instructor in Metallurgy and Ore Dressing.

JAMES RICHARD JOHNSON, B.M.E. (Kentucky State College), Instructor in Wood Work.

FLOYD WILLIAMS PARSONS, E.M. (Lehigh University), Instructor in Civil and Mining Engineering.

CHARLES DUVAL HOHL, B.S., E.M. (Michigan College of Mines), Instructor in Mathematics and Physics.

CHARLES HOMER BAXTER, B.S., E.M. (Michigan College of Mines), Instructor in Civil and Mining Engineering.

ALFRED HERMANN MEUCHE, B.S., E.M. (Michigan College of Mines), Instructor in Civil and Mining Engineering.

CHARLES SINCLAIR STEWART, Instructor in Physical Training and Director of College Club and Gymnasium.

FRANK BROWN WILSON, Assistant in Chemistry.

JOHN PHILIP FURBECK, Assistant in Mechanical Engineering.

THOMAS EMANUEL RICHARDS, Assistant in Shop Practice.

ROBERT SMITHSON FITCH, Assistant in Mineralogy.

GEORGE P. SCHUBERT, B.S. (Michigan College of Mines), Assistant in Civil and Mining Engineering.

CLIFFORD ALOYSIUS BARABE, Assistant in Metallurgy.

ARTHUR HERBERT ROSE, Assistant in Civil Engineering.

ORR ROSS HAMILTON, Assistant in Mechanical Engineering.

LAWRENCE KIMBALL FREEMAN, Assistant in Mechanical Engineering.

EDWARD RAYMOND JONES, Assistant in Mineralogy.

CLARENCE HORACE HITCHCOCK, Assistant in Mineralogy.

OTHER EMPLOYEES

HENRY GIBBS,
Purchasing Agent and Supply Clerk.

HARRY SHARP,
President's Secretary and Accountant.

DONALD FRAMPTON,
Stenographer.

THOMAS EMANUEL RICHARDS,
Engineer.

MAXIME MORIN,
Carpenter.

FREDERICK CHARLES STRASSER,
Chief Janitor.

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FACULTY

Fred Walter McNair, President.

George Augustus Koenig

Frederick William Sperr

Ozni Porter Hood

Arthur Edmund Seaman

James Fisher, Jr.

Leonard Strong Austin

Frances Hanna Scott, Secretary

Admission to the College

1. Admission by Examination.

All students who desire to become candidates for a degree are admitted on examination in the following subjects:

English.—The examination in this subject is intended to test the candidate's ability to command good English. He will be required to write briefly on some subject assigned at the time.

Arithmetic and Metric System.

Bookkeeping.

Algebra, through Quadratic Equations.

Geometry—Plane, Solid and Spherical.

Physics.

Physical Geography or Elements of Astronomy.

2. Admission by Diploma.

Candidates who are graduates of the proper course of a high school accredited to this institution are admitted upon presentation of diploma, together with a record of the subjects pursued and grade obtained in each.

Application to be placed on the accredited list may be made by the principal or superintendent of the school, who shall send to the secretary of the College a copy of the courses of study and list of text-books employed. Copies of examinations which have been set, accompanied with papers which have been written by pupils in answer thereto, must also be forwarded to the College. The subjects covered by these papers must not be less than four, including Mathematics, Physics and one other science subject. If these are satisfactory, the school will be placed provisionally upon the accredited list. The College regards the work done by graduates as ultimately the genuine test of the character of the preparation given by the high school. If therefore the students accepted from such an

accredited school shall be found to be deficient in preparation, the school must expect to be dropped from the list.

In case of any considerable change in the course of study or staff of instructors, the school is expected to notify the College, and if requested, it shall submit further evidence of the character of its work. Students of an accredited school who are not graduates can expect to enter the College by examination only.

The following institutions are now on the accredited list of the College:

Academy of Northwestern University, Evanston, Ill.
Adams Township High School.
Adrian High School.
Alma Academy, Alma, Mich.
Alma High School.
Alpena High School.
Ann Arbor High School.
Baraga High School.
Battle Creek High School.
Belding High School.
Benton Harbor High School.
Bessemer High School.
Binghamton High School, Binghamton, N. Y.
Brown City High School.
Butte Business College, Butte, Mont.
Calumet High School.
Caro High School.
Cass City High School.
Clio High School.
Detroit Central High School.
Detroit Eastern High School.
Detroit Western High School.
Detroit University School.
Duluth High School, Duluth, Minn.
Edgerton High School, Edgerton, Wis.
Ely High School, Ely, Minn.
Englewood High School, Chicago, Ill.
Escanaba High School.
Ferris Institute, Big Rapids.

Flint High School.
Fort Atkinson High School, Fort Atkinson, Wis.
Gladstone High School.
Grand Haven High School.
Grand Rapids Central High School.
Grass Lake High School.
Hadley High School.
Hancock High School.
Houghton High School.
Hyde Park High School, Hyde Park, Chicago, Ill.
Ionia High School.
Iron Mountain High School.
Ironwood High School.
Ispheming High School.
Ithaca High School.
Janesville High School, Janesville, Wis.
Johnstown High School, Johnstown, Pa.
Kalamazoo High School.
Kansas City Manual Training High School, Kansas City, Mo.
Lake Linden High School.
L'Anse High School.
Lansing High School.
Lawrenceville School, Lawrenceville, N. J.
Ludington High School.
Manistee High School.
Manistique High School.
Marinette High School, Marinette, Wis.
Marquette High School.
Menominee High School.
Michigamme High School.
Michigan Military Academy.
Milwaukee Academy, Milwaukee, Wis.
Milwaukee East Side High School, Milwaukee, Wis.
Milwaukee South Side High School, Milwaukee, Wis.
Milwaukee West Side High School, Milwaukee, Wis.
Morgan Park Academy, Morgan Park, Ill.
Muskegon High and Hackley Manual Training Schools.
Negaunee High School.
Niles High School.

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Highland Park, Chicago, Ill.

Princeton, N. J.

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Norway High School.
Oconto High School, Oconto, Wis.
Oshkosh High School, Oshkosh, Wis.
Petoskey High School.
Phœnix High School, Phœnix, Ariz.
Plainwell High School.
Port Huron High School.
Princeton High School, Princeton, Ind.
Racine College, Racine, Wis.
Reed City High School.
Republic High School.
Rockford High School.
Rutger's College Preparatory School, Princeton, N. J.
Ryan High School, Appleton, Wis.
Saginaw East Side High School.
Saginaw West Side High School.
St. Johns Military Academy, Delafield, Wis.
St. Paul High School, St. Paul, Minn.
San Antonio Academy, San Antonio, Tex.
Sault Ste. Marie High School.
Shattuck School for Boys, Faribault, Minn.
Steele High School, Dayton, Ohio.
Three Rivers High School.
Toledo Central High School, Toledo, Ohio.
Township High School, Evanston, Ill.
Township High School, Oak Park, Ill.
Traverse City High School.
University High School, Chicago, Ill.
Wayland Academy, Beaver Dam, Wis.
Worcester Academy, Worcester, Mass.

[redacted]

3. Graduates of Colleges.

Graduates of approved colleges are admitted upon presentation of their diplomas or certificates of graduation. Courses taken at the other institution which may be the equivalent of courses offered here, will be credited toward a degree, under the following conditions: After an informal discussion of the previous work, which must satisfy the instructors from whom credit is asked, as to its scope and thoroughness, provisional credits are given. If the student's subsequent work in this College is satisfactory, the provisional credits are made permanent; if unsatisfactory, the student is assigned to such courses as are necessary to make up the deficiencies. This method is considered to be fair to the student, to the college from which he came, and to this College.

4. Undergraduates of Colleges.

Undergraduates of other colleges must present certificate of honorable dismissal. Credits are given them under the same conditions as outlined for graduates.

5. Special Arrangement.

In many cases persons who have been engaged in practical work until upwards of nineteen years of age, desire to better their condition by obtaining an education which will be of practical use, but they are unable to take the time for a full high school course. Such men often prove to be among the best students, since they realize clearly the purpose of their work and the value of time. For their benefit the College will arrange with the principal or superintendent of any of its accredited schools a special course to cover a minimum of two years' work, and upon the student's completion of this course the College will accept him upon the recommendation of the principal or superintendent.

This arrangement will not be entered into for prospective students who are under nineteen years of age, and only for those over nineteen years of age who can show that they have been employed for at least two years in some position entailing responsibility. The College reserves the right to withdraw this offer at any time that it may deem best.

[redacted]

6. Special Students.

Persons who are not candidates for a degree, and who wish to take special studies, are permitted to do so upon giving satisfactory evidence that they are able to pursue with profit the courses they wish to take. If they subsequently desire to become candidates for a degree, they must pass the required entrance examinations.

Since its organization the College has had many students of mature age who came for certain training which they considered necessary for their subsequent work. These have proved themselves excellent workers, and the College desires to extend to such persons every possible aid. It has assisted in this way numerous practical and active business men who have had years of previous experience, and it desires to continue a work from which valuable results have been obtained in the past.

Outline List of Courses of Instruction Arranged in Order of Sequence

A. MATHEMATICS.

Professor Fisher, Assistant Professor Grant, Messrs. Simpson, Rood, Haigler and Hohl.

A 1. **Algebra.**
Three times a week, thirty-three weeks. To count as one credit. Messrs. SIMPSON, ROOD, HAIGLER and HOHL.

A 2. **Plane Trigonometry.**
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by, or accompanied with A 1 (Algebra). Messrs. SIMPSON, ROOD, HAIGLER and HOHL.

A. 3. **Spherical Trigonometry.**
Two times a week, sixteen weeks. To count as three-tenths of a credit. To be preceded by A 2 (Plane Trigonometry). Professor FISHER, Assistant Professor GRANT, Messrs. ROOD and SIMPSON.

A. 4. **Analytical Geometry.**
Four times a week, twenty-one weeks. To count as nine-tenths of a credit. To be preceded by A 2 (Plane Trigonometry). Assistant Professor GRANT, Messrs. SIMPSON, ROOD, HAIGLER and HOHL.

A 5. **Differential and Integral Calculus.**
Four times a week, twenty-eight weeks. To count as eleven-tenths of a credit. To be preceded by A 4 (Analytical Geometry), and B 1 (Physics), and preceded by, or accompanied with B 4 (Physics). Professor FISHER and Assistant Professor GRANT.

F 5. **Advanced Quantitative Analysis.**
Twelve hours a week, thirty-three weeks. To count as twelve-tenths of a credit. To be preceded by, or accompanied with F 7 (Quantitative Analysis). Professor KOENIG.

F 6. **Synthetic and Theoretical Chemistry.**
Eighteen hours a week, thirty-three weeks. To count as two credits. To be preceded by F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis), and W 3 (Mineralogy). Professor KOENIG.

G. METALLURGY.

Professor Austin, Mr. Copeland and Mr. Barabé.

G 1. **Assaying.**
Lectures and recitations, once a week, sixteen weeks, and one hundred twenty hours laboratory work and recitations. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis), and W 2 (Mineralogy). Professor AUSTIN, Mr. COPELAND and Mr. BARABE.

G 2. **Metallurgy.**
Four times a week, twenty-eight weeks, and twenty-seven hours for excursions and reports on same. To count as eight-tenths of a credit. To be preceded by B 4 (Physics), F 3 (Qualitative Analysis), and preceded by, or accompanied with, G 1 (Assaying), and W 2 (Mineralogy). Professor AUSTIN and Mr. COPELAND.

G 3. **Metallurgical Laboratory Practice.**
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis), G 1 (Assaying), and preceded by, or accompanied with, G 2 (Metallurgy). Professor AUSTIN, Mr. COPELAND and Mr. BARABE.

G 4. **Metallurgical Designing.**
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by, or accompanied with, G 2 (Metallurgy), Q 6 (Graphical Statics) and M 11 (Mechanical Engineering 11). Professor AUSTIN.

C. MECHANICS.

Professor Fisher, Assistant Professor Grant and Mr. Rood.

C 1. **Analytic Mechanics.**
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by, or accompanied with A 5 (Calculus). Professor FISHER, Assistant Professor GRANT and Mr. ROOD.

C 2. **Analytic Mechanics.**
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by C 1 (Analytic Mechanics). Professor FISHER and Assistant Professor GRANT.

F. CHEMISTRY.

Professor Koenig, Dr. Fernekes, Dr. Koch and Mr. Wilson.

F 1. **General Experimental Chemistry.**
Twelve hours a week, twenty-eight weeks. To count as eleven-tenths of a credit. Professor KOENIG and Mr. WILSON.

F 2. **Blowpipe Analysis.**
Twelve hours a week, five weeks. To count as two-tenths of a credit. To be preceded by F 1 (General Experimental Chemistry). Professor KOENIG, Dr. KOCH and Mr. WILSON.

F 3. **Qualitative Analysis.**
Twelve hours a week, twenty-eight weeks. To count as eleven-tenths of a credit. To be preceded by F 2 (Blowpipe Analysis). Professor KOENIG and Dr. KOCH.

F 4. **Volumetric Analysis.**
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis). Professor KOENIG and Dr. FERNEKES.

F 7. **Quantitative Analysis.**
Twelve hours a week, twenty-one weeks. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis). Professor KOENIG and Dr. FERNEKES.

M 15. Mechanical Drawing.
Fifteen hours a week, twelve weeks. To count as six-tenths of a credit. Mr. DeLay, Mr. Hamilton and Mr. Freeman.

M 16. Machine Drawing.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). Mr. DeLay, Mr. Hamilton and Mr. Freeman.

M 1. Properties of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics) and F 1 (General Chemistry), and preceded by, or accompanied with, B 4 (Physics). Assistant Professor Christensen.

M 5. Mechanical Engineering I.
Three times a week, twelve weeks. To count as four-tenths of a credit. Professor Hood.

M 11. Mechanical Engineering II.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. To be preceded by M 5 (Mechanical Engineering I.), M 15 (Mechanical Drawing), M 1 (Properties of Materials) and M 2 (Shop Practice). Professor Hood.

M 4. Mechanics of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by M 1 (Properties of Materials), and preceded by, or accompanied with C 2 (Analytic Mechanics). Assistant Professor Christensen.

M 6. Testing Materials of Engineering.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 4 (Mechanics of Materials). Professor Hood and Assistant Professor Christensen.

M 10. Pumps and Pumping Machinery.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and preceded by, or accompanied with C 2 (Analytic Mechanics). Professor Hood.

M 14. Air Compression and Air Machinery.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 10 (Pumps and Pumping Machinery). Professor HOOD.

M 3. Design of Structural Joints.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by, or accompanied with M 4 (Mechanics of Materials). Assistant Professor CHRISTENSEN.

M 12. Mechanical Engineering III.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and preceded by, or accompanied with C 2 (Analytic Mechanics), and fall term of M 4 (Mechanics of Materials). Professor HOOD.

M 13. Mechanical Engineering IV.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 12 (Mechanical Engineering III.). Professor HOOD.

M 9. Mechanical Engineering Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 13 (Mechanical Engineering IV.). Professor HOOD and Assistant Professor CHRISTENSEN.

N. ELECTRICAL ENGINEERING.

Professor Hood and Mr. DeLay.

N 1. Electrical Engineering.
Three hours a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and B 3 (Electrical Measurements). Mr. DELAY.

N 3. Electrical Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by N 1 (Electrical Engineering). Professor HOOD and Mr. DELAY.

Q. CIVIL ENGINEERING.

Professor Sperr and Messrs. Baxter, Schubert, Meuche, Rose and ——.

Q 4. Topographical Drawing.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). Mr. MEUCHE.

Q 1. Surveying (Field Work).
Fifty hours a week, twelve weeks. To count as two and two-tenths credits. To be preceded by A 3 (Spherical Trigonometry), and Q 4 (Topographical Drawing). Professor SPERR and Messrs. BAXTER, SCHUBERT, MEUCHE, ROSE and ——.

Q 5. Surveying (Office Work).
Ten hours a week, eleven weeks. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying). Mr. MEUCHE.

Q 6. Graphical Statics.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. To be preceded by B 1 (Physics), and M 15 (Mechanical Drawing). Messrs. SCHUBERT and ROSE.

Q 7. Engineering Design and Construction.
Twelve hours a week, sixteen weeks. To count as seven-tenths of a credit. To be preceded by Q 6 (Graphical Statics), and preceded by, or accompanied with M 4 (Mechanics of Materials), and R 4 (Mining Engineering). Professor SPERR and Mr. MEUCHE.

Q 2. Hydraulics.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining), and preceded by, or accompanied with A 5 (Calculus). Mr. BAXTER.

Q 3. Hydraulics.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by Q 2 (Hydraulics) and M 5 (Mechanical Engineering I.). Professor SPERR and Mr. BAXTER.

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R. MINING ENGINEERING.

Professor Sperr and Messrs. Baxter, Schubert, Meuche, Rose and Hartness.

R 1. Principles of Mining.
Eleven hours a week, sixteen weeks. To count as six-tenths of a credit. Excursions to the mines, etc. This subject is required of all candidates for the B.S. and E.M. degrees. To be preceded by, or accompanied with, Y 1 (Principles of Geology). Professor SPERR and Mr. MEUCHE.

R 2. Mine Surveying and Mining (Classroom Work).
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by Q 1 (Surveying) and R 1 (Principles of Mining). Professor SPERR and Mr. BAXTER.

R 3. Mine Surveying and Mining (Field Work).
Fifty-four hours a week, five weeks. To count as one credit. To be preceded by R 2 (Mine Surveying and Mining), except for students who enter for this subject alone, who are required to be prepared in Algebra, Geometry, Trigonometry, and in the use of the transit and level. Professor SPERR, Messrs. BAXTER, SCHUBERT, ROSE and HARTNESS.

R 4. Mining Engineering.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by C 2 (Analytic Mechanics), R 3 (Mine Surveying and Mining), and Q 2 (Hydraulics), and preceded by, or accompanied with, M 4 (Mechanics of Materials). Professor SPERR.

R 5. Mine Management and Accounts.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by R 3 (Mine Surveying and Mining). Professor SPERR.

R 6. Mine Ventilation.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by M 5 (Mechanical Engineering I.) and Q 2 (Hydraulics). Professor SPERR.

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V. BIOLOGY.

Professor Seaman and Mr. Hancock.

V 2. **Palaeontology.**
Twelve hours a week, twelve weeks. To count as five-tenths of a credit.

W. MINERALOGY.

Professor Seaman, and Messrs. Hancock, Bowen and Corey.

W 4. **Elementary Mineralogy and Crystallography.**
Fourteen hours a week, twelve weeks, and *three hours a week* for sixteen weeks. To count as eight-tenths of a credit. Professor SEAMAN, and Messrs. COREY, HANCOCK and BOWEN.

W 1. **Crystallography.**
Nine hours a week, twelve weeks. To count as four-tenths of a credit. To be preceded by, or accompanied with, W 4 (Elementary Mineralogy and Crystallography). Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

W 2. **Mineralogy.**
Twelve hours a week, sixteen weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics), F 2 (Blowpipe Analysis), W 1 (Crystallography), and Y 1 (Principles of Geology). Professor SEAMAN, and Messrs. COREY, HANCOCK and BOWEN.

W 3. **Advanced Mineralogy.**
Six hours a week, twenty-three weeks. To count as five-tenths of a credit. To be preceded by W 2 (Mineralogy), and accompanied with X 2 (Petrography). Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

X. PETROGRAPHY.

Mr. Corey and Mr. Bowen.

X 1. **Petrography.**
Nine hours a week, twenty-eight weeks. To count as eight-tenths of a credit. To be preceded by Y 1 (Principles of Geology), and preceded by, or accompanied with B 5 (Light), and W 4 (Elementary Mineralogy and Crystallography).

X 2. **Advanced Petrography.**
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by X 1 (Petrography), and accompanied with W 3 (Mineralogy).

Y. GEOLOGY.

Professor Seaman, and Messrs. Corey, Bowen and Hancock.

Y 1. **Principles of Geology.**
Two times a week, twelve weeks, and *one time a week,* sixteen weeks. To count as four-tenths of a credit. To be preceded by, or to accompany, W 4 (Elementary Mineralogy and Crystallography). This subject is required of all candidates for B.S. and E.M. degrees. Professor SEAMAN, and Messrs. COREY and BOWEN.

Y 3. **Physical and Chemical Geology.**
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by W 2 (Mineralogy), and preceded by, or accompanied with X 1 (Petrography). Professor SEAMAN and Mr. COREY.

Y 2. **Historical Geology.**
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology). Professor SEAMAN and Mr. HANCOCK.

Y 4. **Geological Field Work.**
Forty-five hours a week, six weeks. To count as one credit. To be preceded by Q 1 (Surveying), and Y 2 (Historical Geology). Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

Y 5. **Economic Geology.**
Three times a week, twenty-eight weeks. To count as nine-tenths of a credit. To obtain credit in this subject, it is necessary to have credit in W 3 (Mineralogy), X 2 (Petrography), and Y 4 (Geological Field Work).

J. THESIS.

The Faculty.

J 1. Thesis.

Properly qualified students may include the preparation of a thesis in their work for a degree. To count as one credit.

PHYSICAL TRAINING.

Mr. Stewart.

Classes five afternoons and three evenings each week throughout the year. Individual practice and general exercise at any time except class hours. Open to all students.

Departments of Instruction

A. MATHEMATICS.

Professor Fisher, Assistant Professor Grant, Messrs. Simpson, Rood, Haigler and Hohl.

As will be seen by a detailed examination of the following pages, the subjects of this department form the necessary foundation for a great part of the student's subsequent work; and they are given as a preparation for this work, as well as for their value in actual engineering practice, and in affording mental discipline.

It is the intention, therefore, to give the instruction in this department in such a manner as will make prominent those subjects or portions of subjects which will be of actual use to the student, and, later, to the engineer. The value of the study of mathematics in developing the power to do vigorous and logical thinking is not underestimated, but it is thought that the effort to master the logic of the subjects necessary to the engineer will afford the student ample opportunity to develop this power.

Every effort is made to see that the student takes advantage of the opportunity thus offered. At each step of his progress he is required to think. The ability to describe a given method, or to correctly quote a given formula, and to apply either to a given case, is in no instance accepted as sufficient. The student is required to logically derive the method of formula, and to demonstrate its correctness.

The courses offered in mathematics are the following:

A 1. Algebra.

Messrs. Simpson, Rood, Haigler and Hohl.

The course includes the Theory of Limits, Logarithms, Progressions, Binomial Theorem, Undetermined Co-efficients, Series and the solution of higher equations. Special attention is paid to the

slide rule, graphical solutions, and practical applications. Wentworth's College Algebra is used as the text book.

Three times a week, thirty-three weeks. To count as one credit.

A 2. Plane Trigonometry.

Messrs. SIMPSON, ROOD, HAIGLER and HOHL.

The ratio system is used exclusively, and prominence is given to the solution of trigonometric equations, and the transformation of trigonometric expressions. The fall term's work in A 1 (Algebra) must precede or be taken along with this course. Wells's Plane and Spherical Trigonometry is used as the text book.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit.

A 3. Spherical Trigonometry.

Professor FISHER, Assistant Professor GRANT, Messrs. SIMPSON and ROOD.

Under this head is given the solution of Right and Oblique spherical triangles with application to the simpler problems of Spherical Astronomy, such as the student will need in his surveying.

The text used is the same as A 2 (Plane Trigonometry).

Two times a week, winter term and first five weeks of the spring term. To count as three-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry).

A 4. Analytic Geometry.

Assistant Professor GRANT, Messrs. SIMPSON, ROOD, HAIGLER and HOHL.

The course covers the straight line, conic sections, a few higher plane curves, transformation of co-ordinates, general equations of the second degree, and an introduction to geometry of three dimensions. The object is to familiarize the student with methods rather than with any set of curves. Given partly by lectures and partly from Tanner & Allen's Analytic Geometry.

Four times a week, twenty-one weeks, winter and spring terms. To count as nine-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry), and preceded by, or accompanied with A 1 (Algebra).

A 5. Differential and Integral Calculus.

Professor FISHER and Assistant Professor GRANT.

The Differential Calculus is developed from a rate as its fundamental notion. The Integral Calculus is from the beginning treated as a method of summation. The object of the course is to give the student a thorough working knowledge of the subject, to put him in possession of a tool of which he can afterward make efficient use. It is believed that this can best be accomplished by giving him a rigorously logical basis for his methods and formulas; and the attempt to do this is therefore made. Applications of differentiation to Expansion in Series, Indeterminate Forms, Maxima and Minima, etc., are treated; while problems of Area, Volume, Work, Pressure, etc., introduce the subject of integration, and their treatment is carried along simultaneously with that of methods. Approximate methods of integration, including the polar planimeter, receive particular attention.

The Calculus is given by lectures, with printed notes, and Taylor's Differential and Integral Calculus as a text book. *Four times a week,* twenty-eight weeks, fall, winter and first half of spring terms. To count as eleven-tenths of a credit. Must be preceded by A 4 (Analytic Geometry), and B 1 (Physics), and preceded by, or accompanied with B 4 (Physics).

A 6. Introduction to Differential Equations.

Professor FISHER.

An introduction to Differential Equations, which includes the treatment of those special equations which the student will meet in his study of Mechanics and Electricity.

The course is given by lectures and recitations. *Four times a week,* last five weeks of the spring term. To count as two-tenths of a credit. Open to those who have credit for A 5 (Calculus).

slide rule, graphical solutions, and practical applications. Wentworth's College Algebra is used as the text book.

Three times a week, thirty-three weeks. To count as one credit.

A 2. Plane Trigonometry.

Messrs. SIMPSON, ROOD, HAIGLER and HOHL.

The ratio system is used exclusively, and prominence is given to the solution of trigonometric equations, and the transformation of trigonometric expressions. The fall term's work in A 1 (Algebra) must precede or be taken along with this course. Wells's Plane and Spherical Trigonometry is used as the text book.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit.

A 3. Spherical Trigonometry.

Professor FISHER, Assistant Professor GRANT, Messrs. SIMPSON and ROOD.

Under this head is given the solution of Right and Oblique spherical triangles with application to the simpler problems of Spherical Astronomy, such as the student will need in his surveying.

The text used is the same as A 2 (Plane Trigonometry).

Two times a week, winter term and first five weeks of the spring term. To count as three-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry).

A 4. Analytic Geometry.

Assistant Professor GRANT, Messrs. SIMPSON, ROOD, HAIGLER and HOHL.

The course covers the straight line, conic sections, a few higher plane curves, transformation of co-ordinates, general equations of the second degree, and an introduction to geometry of three dimensions. The object is to familiarize the student with methods rather than with any set of curves. Given partly by lectures and partly from Tanner & Allen's Analytic Geometry.

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Four times a week, twenty-one weeks, winter and spring terms. To count as nine-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry), and preceded by, or accompanied with A 1 (Algebra).

A 5. Differential and Integral Calculus.

Professor FISHER and Assistant Professor GRANT.

The Differential Calculus is developed from a rate as its fundamental notion. The Integral Calculus is from the beginning treated as a method of summation. The object of the course is to give the student a thorough working knowledge of the subject, to put him in possession of a tool of which he can afterward make efficient use. It is believed that this can best be accomplished by giving him a rigorously logical basis for his methods and formulas; and the attempt to do this is therefore made. Applications of differentiation to Expansion in Series, Indeterminate Forms, Maxima and Minima, etc., are treated; while problems of Area, Volume, Work, Pressure, etc., introduce the subject of integration, and their treatment is carried along simultaneously with that of methods. Approximate methods of integration, including the polar planimeter, receive particular attention.

The Calculus is given by lectures, with printed notes, and Taylor's Differential and Integral Calculus as a text book. *Four times a week,* twenty-eight weeks, fall, winter and first half of spring terms. To count as eleven-tenths of a credit. Must be preceded by A 4 (Analytic Geometry), and B 1 (Physics), and preceded by, or accompanied with B 4 (Physics).

A 6. Introduction to Differential Equations.

Professor FISHER.

An introduction to Differential Equations, which includes the treatment of those special equations which the student will meet in his study of Mechanics and Electricity.

The course is given by lectures and recitations. *Four times a week,* last five weeks of the spring term. To count as two-tenths of a credit. Open to those who have credit for A 5 (Calculus).

B. PHYSICS.

The President, Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Simpson, Rood and Hohl.

The aim in the department of Physics, as in that of Mathematics, is to select such objects as have, directly or indirectly, a bearing on the practical work of the mining engineer, and to treat these in as practical a manner as possible. The instruction is given by the laboratory method. The student goes at once into the laboratory, and there, under the direction of the instructors, experiments for himself. The experiments are mostly quantitative.

So far as possible, mere mechanical following of direction is excluded, and intelligent thinking is made necessary to the accomplishment of the work. Every effort is put forth to have the student clearly develop and fix in his mind the principles of Physics which he will afterward use, and also to lay the foundation for that skill in accurate determination of quantity and care of delicate apparatus which are needed by the practical engineer. Accuracy and order are insisted on from the first. Each student receives individual attention, and, with the exception of a few experiments requiring more than one observer, he does his work independently of all other students.

The work of the laboratory is accompanied by illustrated lectures, and by text-book and recitation work.

The department is equipped with a good assortment of modern apparatus for lecture illustration and individual experiment.

B 1. General Physics.

Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, SIMPSON, ROOD and HOHL.

An elementary course including Mechanics, Heat and Light. Lecture, recitation and laboratory work proceed together throughout the course. The geometrical side of Light is developed mostly in the laboratory, the wave theory in the lecture room with the optical lantern and the arc light.

Twelve hours a week, twenty-one weeks, winter and spring terms. To count as eight-tenths of a credit. Must be preceded by, or accompanied with, A 1 (Algebra) and A 2 (Plane Trigonometry).

B 2. Physical Measurements.

Professor Fisher and Assistant Professor Grant.

A more advanced course in measurements of precision, open to those who have taken B 1 and B 4 (Physics). The work offered will be mainly in the determination of densities, moments of inertia, calorimetry and photometry. Each student will work independently of all others, and to a considerable extent the choice of the line of work he is to pursue will lie with him. Text books are Nichol's Manual of Laboratory Physics, and Stewart and Gee's Elementary Practical Physics, Vols. I and III.

Twenty-four hours a week, last five weeks of the spring term. To count as four-tenths of a credit.

B 3. Electrical Measurements.

Professor Fisher and Mr. Hohl.

The increasing use of electricity in mining and related industries has caused the Michigan College of Mines to give particular attention to this subject.

This course is offered to those who are making Electrical Engineering their principal subject, to those who intend taking up Electrolytic or Electro-metallurgical work, and to any others who wish to become familiar with those modern methods of electrical measurement necessary wherever there is made any practical application of this agent.

In the course are included the measurement of Current, Resistance, Potential Difference, Electromotive Force, Quantity, Capacity, Mutual and Self Induction, Strength of Field, etc.

In the lecture room the theory of a given measurement is taken up; then the construction and calibration of the instrument used in the measurement are studied, the instrument being at hand for inspection; and, finally, in the laboratory, the student calibrates, if necessary, and uses the instrument in making the measurement.

Examples of all the principal instruments used in modern electrical methods are owned by this institution, and are available for the work of this course.

The text books are Carhart and Patterson's Electrical Measurements, and Nichol's Laboratory Manual.

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Nine hours a week, sixteen weeks in the winter and first five weeks of spring terms. To count as five-tenths of a credit. To be preceded by C 1 (Analytic Mechanics).

B 4. General Physics.

Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, SIMPSON, ROOD and HOHL.

Subject B 4 continues the work begun in B 1, and includes Heat and an elementary course in Magnetism and Electricity. Text books used are Glazebrook's Heat, printed notes on Magnetism and Electricity, and Jackson's Electricity and Magnetism.

Twelve hours a week, twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics).

B 5. Light.

The PRESIDENT and Professor FISHER.

A more advanced course continuing the work begun in this subject in B 1 (Physics). The course is designed particularly for those students who desire to take up Petrography. It deals chiefly with polarization. The subject is presented by experimental lectures which are followed up with individual experiment. A very complete outfit of projection apparatus made by Newton & Co., London, is in the possession of the department for use in this course.

Six hours a week, twelve weeks. Fall term. To count as two-tenths of a credit. To be preceded by B 1 (Physics).

C. MECHANICS.

Professor Fisher, Assistant Professor Grant and Mr. Rood.

An attempt is made in Mechanics to develop the essential principles, and to render the student proficient in applying them to practical rather than theoretical problems. To this end a large number of problems are solved which, so far as possible, are selected from machines or structures with which the student is already familiar, or the study of which he is subsequently to take up.

C 1. Analytic Mechanics.

Professor Fisher, Assistant Professor Grant and Mr. Rood.

Church's Mechanics of Engineering, Parts I and II, Statics and Dynamics, is made the basis of this and the following course.

Subject C 1 occupies three hours in class room and three in the Laboratory each week for sixteen weeks, in the winter and first half of spring terms. To count as five-tenths of a credit.

To be preceded by, or accompanied with, A 5 (Calculus).

C 2. Analytic Mechanics.

Professor Fisher and Assistant Professor Grant.

Subject C 2 continues the work begun in C 1, and is given three hours in class room and three in the laboratory each week, twelve weeks, in the fall term. To count as four-tenths of a credit.

To be preceded by C 1 (Analytic Mechanics).

F. CHEMISTRY.

Professor Koenig, and Dr. Fernekes, Dr. Koch and Mr. Wilson.

Equipment.

The *Laboratory for General and Experimental Chemistry* is a room 31½ x 51 feet, situated in the basement of the northeast wing of the Chemistry building. The room receives light from three of its sides. Five desks provide table and closet space for ninety students. A continuous hood runs around three walls of the room with a total length of 102 feet, enabling forty-five students to make use of the hood at one time. The north wall hood is six feet high and is made fire proof. Here all experiments requiring high temperature are performed in wind furnaces, muffle furnaces and gas furnaces. The instructor's private room opens into the main laboratory. Another adjoining room contains all the special apparatus, which is accessible to the students through the instructor.

The *Laboratory for Qualitative Analysis* occupies the west wing of the main floor. The room is 40 x 33 feet. Five desks give working and closet space for sixty-four students, with one sink for four

places. A continuous hood runs along three of the walls. This hood is divided into compartments of five feet each, to be occupied by one or two students at a time. Each compartment contains two permanent self-supplying water-baths and two gas stop-cocks. Four of the compartments have two Koenig's Hydrogen-sulfid generators, each permanently mounted. The hoods are supplied with mains for water, gas and compressed air, the latter to be used chiefly for rapid evaporation on the water baths; from each compartment the foul gases and vapors are drawn by fan-suction whilst a large volume of fresh air of the proper temperature is constantly blown into the room by a pressure fan. A dark room for spectroscopic work, and the instructor's office, open into this laboratory.

The *Laboratory for Quantitative Analysis* occupies the east wing of the main floor. It is 39½ x 33 feet. Four desks accommodate forty students; allowing each man four feet, and a sink for every four men. A hood runs along each of the long sides, divided into compartments and furnished the same as in the Qualitative Laboratory, except that two compartments only contain Koenig's Hydrogen-sulfid generators, whilst two other compartments are furnished each with a Koenig's Chlorine and Hydrogen generator, a combustion furnace and a Shimer apparatus for carbon determinations. The weighing room opens directly into the laboratory, but it has exclusive northern light. It is furnished with twelve analytical balances of the best make; one for four students. The laboratory for *Gas Analysis* is located alongside of the weighing room. It has light from the north only and can be kept at a uniform temperature. It is furnished with Hempel's and Bunsen's apparatus, both for working over water and working over mercury. The instructor's office and the *Electrolytic* room adjoin the laboratory on the south wall. The electrolytic room contains desks for electrolytic determinations with six working spaces, each of which is furnished with a separate resistance, a voltmeter and a milli-am-meter. In this room is the Glass-Blower's table.

The *Laboratory for Advanced Quantitative Analysis* has working facilities for eight students. But there is a laboratory for special work in which synthetic work and research work can be carried on by a few students. This laboratory is located alongside the professor's office on the main floor.

The class instruction is given in a spacious lecture room, which

is located at the east end of the second floor. This room seats 132 students in nine rows, each row being three inches higher than the preceding one. The lecture desk is furnished in the modern manner, with the electric current, and switch-board arrangements, also with water, gas and compressed air. The desk is unobstructed by any hood. Experiments generating noxious gases are carried on in a hood which stands in the adjoining preparation room behind a movable glass panel. When the latter is raised the apparatus under the hood will be visible from all parts of the room. Provision is made for the display of charts and diagrams in front of and above the black-boards behind the lecture table.

The supply clerk's office and store-rooms are located in the basement, but are connected with the main floor by means of a dumb waiter.

F 1. General Experimental Chemistry.

Professor Koenig and Mr. Wilson.

Twelve hours a week, twenty-eight weeks; one recitation, three lectures, and six hours of laboratory work each week; to count as eleven-tenths of a credit.

The instruction in this subject covers the following ground:

First. Experiments with the common metals, their action when heated in air, and when heated in the absence of air; discovery of the composite nature of air; a life sustaining part (ozone); a life destroying part (azote). Specific gravity of azote by direct weight and of ozone by calculation. The increase in weight of metals when heated in air, discovery of ozonites (oxides). Ratio of increase. Burning of sulphur in air, discovery of a gaseous sulphur ozonite possessing an acid taste; change of the name ozone into oxygen. Restoration of the original metals from the oxyds by the action of charcoal; hence the notion of elements or simple bodies. Action of the common metals at a red heat upon steam, the forming of bodies similar to the oxides and of an inflammable gas; discovery of hydrogen and its properties. Proving the identity of water oxides with air oxides, hence the conclusion that water is a combination of oxygen with hydrogen.

Second. (1) The study of copperas or vitriol. Under the action of heat it yields an oily liquid—the oil of vitriol. Correlation

of this body with sulphur oxide. With the oil of vitriol the student has gained now a powerful reagent, but he does not know, and should not be told at this stage of his development that this oil of vitriol is $H^2 SO^4$. The body is for his purposes simply oil of vitriol, for which the symbol Ov may stand.

(2) Study of potash, soda ash, limestone. Their action with heat, with heat and charcoal, with oil of vitriol. Their action upon each other; of burnt lime upon potash. Discovery of potassium, sodium, calcium, of caustic soda, caustic potash, and of a non-life-sustaining, heavy, slightly sour gas, lime gas (Not CO_2). Alkaline reaction, acid reaction; the notion of hydroxides, of acid hydroxides and of basic hydroxides.

(3) Study of common salt, the mother-liquor salt, and the varec salt; the spirits of salt. Decomposition into a green gas and hydrogen. Chlorine, probably a simple body. Bromine, iodine, fluorine. Action of chlorine upon hydrogen in equal volumes. The theory of combinations by volumes; the notion of *molecules* and *atoms;* of molecular weights and atomic weights. The action of chlorine upon the common metals—the chlorides, their properties. Reproduction of salt by acting with spirits of salt upon soda-ash—hence the identity of the metal in salt and soda-ash. Atomic weight of sodium and potassium by experiment.

(4) The study of nitre. Action in heat. Yields a gas which sustains combustion and animal breathing. Identification of this gas with the ozone or oxygen of the air. The notion of super or peroxides. The spirits of nitre. Its action upon the metals. Discovery of nitrogen and identification of this gas with the ozote of the air. The several oxides of nitrogen. Nitrogen chloride. Action of zinc and caustic potash upon nitre. Discovery of gaseous alkaline body: Ammonia. Study of its properties and combinations; ammonium salts.

(5) The study of sulphur. The oxides and chlorides of sulphur. The manufacture of hydrogen sulphate.

(6) Discovery of carbon by decomposing the limestone gas with sodium. Identification of this body with the substance of charcoal, of mineral coal, of plant and animal structures. The mineral oils, the natural gases. The fats, alcohols, ethers, albumenoid bodies. Discovery of cyanogen and its principal compounds.

(7) The study of bone-ash and discovery of phosphorus-oxides and hydroxides of phosphorus.

(8) The study of borax and quartz; borum and silicon.

(9) Theoretical deductions. Electrolysis. Thermo-chemistry. Structural and stereographic formulæ.

The students may take notes during the lectures but are not *required* to do so, so that the whole attention can be given to the following of the manipulation in the experiments.

F 2. Blowpipe Analysis.

Professor Koenig, Dr. Koch and Mr. Wilson.

Twelve hours a week, five weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as two-tenths of a credit. The lectures are merely a continuous set of demonstrations by the professor to show how the reactions should be made.

This is a short course in Qualitative Analysis in which preference is given to reactions in the igneous way, so that students may be enabled to take the course in Mineralogy with full benefit.

Brush's tables and Landauer's small treatise are referred to.

To be preceded by F 1 (General Chemistry).

F 3. Qualitative Analysis.

Professor Koenig and Dr. Koch.

Twelve hours a week, twenty-eight weeks. Two lectures, one recitation and eight hours of laboratory work each week. To count as eleven-tenths of a credit. To be preceded by F 2 (Blowpipe Analysis).

This course embraces the chemistry of the metals and their technically important salts. In the case of gold, for instance, the student receives 200 mgrs. of the pure metal and after having converted it into the prescribed compounds and studied the reactions, must return the gold as pure metal. As this is time-taking the course has been extended beyond the usual limit.

F 4. Volumetric Analysis.

Professor Koenig and Dr. Fernekes.

Twelve hours a week, for twelve weeks. To count as five-tenths of a credit. Two lectures and one recitation a week. To be preceded by F 3 (Qualitative Analysis).

The course comprises: Alkalimetry, acidemetry. Volumetric analysis of limestone and marl. Analysis of copper ores by gravimetric, volumetric, colorimetric and electrolytic methods in order that the student may learn their relative merits. Permanganate, dichromate and iodometric methods.

Sutton's Volumetric Analysis for reference.

F 5. Advanced Quantitative Analysis.

Professor Koenig.

Twelve hours a week, thirty-three weeks. One lecture, one recitation and eight hours of laboratory work a week. To count as twelve-tenths of a credit.

This course embraces: the analysis of fats, oils and soaps; the extraction and estimation of poisons; the analysis of fertilizers; the analysis of explosives; the estimation and separation of the rare elements in minerals; analysis of samarskite; nitrometry, and oxygenometry. Gas Analysis, according to Bunsen, Hempel and Winkler. Theoretical chemistry.

To be preceded by, or accompanied with F 7 (Quantitative Analysis).

F 6. Synthetic and Theoretical Chemistry.

Professor Koenig.

Eighteen hours a week, thirty-three weeks. To count as two credits. Candidates must have completed subjects F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis) and W 3 (Mineralogy).

This course is intended as an amplification of the course in General Chemistry, to cultivate the field of original discovery and

invention; to produce with known reactions a desired commercial result. The modern theories based upon the physico-chemical researches of late years are to be fully discussed and compared with former notions upon the constitution of chemical compounds. Students who wish to take this course must have shown by their previous work that they possess the required originality of mind and practical sense. To all others it is a waste of time. The students are required to read much chemical literature and to discuss their reading in a seminar to be appointed from time to time. The subjects of experimentation may either originate with the student or may be suggested by the professor.

The student must keep a minute account of all his work, in arranging the apparatus, as well as in the actual experiment, whether the latter be a failure or a success.

F 7. Quantitative Analysis.

Professor Koenig and Dr. Fernekes.

Twelve hours a week, twenty-one weeks; two lectures and one recitation a week. To count as nine-tenths of a credit.

Course embraces: (1) Analysis of iron ores. The sample is made up to contain all the elements likely to be of importance in iron ores. In the soluble portion are to be determined volumetrically iron, copper, manganese, phosphorus, sulphur. In the insoluble portion are determined the oxides SiO_2, TiO_2, Cr_2O_3, Fe_2O_3, CaO and MgO by gravimetric methods. (2) Analysis of Pig Iron and Steel, including colorimetric estimation of carbon and manganese. (3) Analysis of Matte and Speiss, embracing the separations of arsenic, antimony, tin, bismuth, silver, copper, cadmium, zinc and iron.

The lecture notes serve as a guide, but the student is referred to the digests of Fresenius, Classen, E. F. Smith.

To be preceded by F 4 (Volumetric Analysis).

G. METALLURGY.

Professor Austin, Mr. Copeland and Mr. Barabè.

G 1. Assaying.

Professor AUSTIN, Mr. COPELAND and Mr. BARABE.

Lectures and recitations *once a week*, sixteen weeks, winter and first half of spring terms, and one hundred twenty hours of laboratory work, including half-hour daily recitations. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis) and W 2 (Mineralogy).

The Fire-Assaying comprises: Assay of ores and metallurgical products for silver, gold and lead by scorification and crucible methods; also the assay of silver bullion, base bullion and of rich silver sulphides for gold and silver.

G 2. Metallurgy.

Professor AUSTIN and Mr. COPELAND.

One hundred and thirty-nine hours as follows: Four recitations a week and four inspection trips to metallurgical plants on given Saturdays, including a trip to Marquette. Fall, winter and first half of spring terms. To count as eight-tenths of a credit. To be preceded by F 3 (Qualitative Analysis), and preceded by, or accompanied with, G 1 (Assaying), and W 2 (Mineralogy).

This course has been arranged to emphasize the particular requirements of the mining engineer, as well as for those who are intending to specialize in metallurgy.

The instruction covers the following subjects:

(1) *Ores*, their characteristics, classification and qualities.

(2) *Sampling* of ores and products.

(3) *Preparation of Ores.* Crushing, crushing machinery, and the kinds and fineness of crushing.

(4) *Fuels*, natural and artificial, manufacture of fuels, gas producers and apparatus.

(5) *Fluxes and metallurgical reagents.*

(6) *Refractory materials,* basic, neutral and acid and their application.

(7) *Gold.* Roasting, Cyaniding, Chlorination.

(8) *Silver.* Ores and their occurrence. Roasting, Hyposulphite leaching, Russell process. Cyaniding of silver ores.

(9) *Iron.* Blast furnace production of pig iron. Ores of iron, blast furnace and accessories, blast furnace reactions, calculation of furnace charges, pig iron.

(10) *Copper* (with accompanying gold and silver). Ores of copper. Roasting, blast furnace matte smelting, pyritic smelting, reverberatory matte smelting. Smelting of oxidized copper ores to pig copper. Refining to blister copper. Copper converting. Hydro-metallurgy of copper.

(11) *Lead* (with gold, silver and copper). Lead and other ores, classification and sampling of ores. Crushing, roasting, and bedding ores. Smelting ores for lead only. Blast furnace smelting with lead as collector. Calculation of charges. Furnace products and their treatment. Costs in smelting.

(12) *Zinc.* Ores of zinc. Roasting. Retorting and furnaces.

(13) *Refining* of crude metals and products of ore reduction. Refining base bullion, of matte and blister copper, of gold and silver bullion, of pig iron into steel and wrought iron.

(14) *Commercial aspects of the treatment of ores.* Prices and marketing, sampling, assaying and grading. Labor and prices. Management of labor (American, Mexican and other). Rules of works. Skilled and unskilled labor. Duties of office force. Discipline. Pay and salaries. Supplies, accounts, estimates and costs.

(15) *Estimates,* of works or plants, operations and profits. Values of ores.

G 3. Metallurgical Laboratory Practice.

Professor Austin and Mr. Copeland.

Nine hours a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis) and G 1 (Assaying), and preceded by, or accompanied with G 2 (Metallurgy).

The instruction will comprise recitations and laboratory work as follows:

Amalgamation of ores of gold and silver.
Leaching methods for the extraction of gold, silver and copper.
Pyrometry.
Manufacture and properties of refractory materials.
Properties of copper.
Roasting, oxidizing, chloridizing and sulphurating.
Lead refining, separation and refining of silver and gold.
Retorting of zinc ores.

G 4. Metallurgical Designing.

Professor AUSTIN.

Nine hours a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. To be preceded by, or accompanied with, G 2 (Metallurgy), Q 6 (Graphic Statics) and M 11 (Mechanical Engineering II.).

The work is mostly in the drawing room with reference to books, catalogues, drawings, models and the actual machines and plants. Students are taught to take full and accurate notes and to work therefrom. They make the needed calculations and study the design and operation of furnaces, etc. They also work on the design and equipment of metallurgical plants, and make estimates of their cost.

G 5. Metallurgical Organization.

Professor AUSTIN.

Nine hours a week, twelve weeks, fall term. To count as three-tenths of a credit. To be preceded by, or accompanied with, G 2 (Metallurgy).

The course of instruction will consist of lectures on the principles of organization and on the duties of the officers and accounting force of a metallurgical establishment.

The subject is divided as follows:

Organization of companies and of working forces. Management, superintendence, skilled and unskilled labor. Constitution of capital; stocks, bonds, dividends and profits.

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Conyngton on Corporation Management will be used as a text book, and references will be looked up and notes made by the student.

G 6. Metallurgical Accounting.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy).

The course of instruction includes the accounting and bookkeeping necessary in a metallurgical works. It takes up the costs and expenses of operation, of ore supply, fuel, fluxes, by-products and markets. It considers sinking funds, insurance, deterioration and repairs, balance sheets and annual statements.

G 7. Practice Work in Metallurgy.

Professor AUSTIN and Mr. COPELAND.

Forty-five hours a week, three weeks, first half of summer term. Blast furnace work. To count as five-tenths of a credit. To be preceded by G 3 (Metallurgical Laboratory Practice).

The blast furnace practice will include the receiving, sampling and bedding of the ores, assaying and determining the ores, fluxes and fuel. Starting and operating the blast furnace. Cleaning up, sampling and analyzing the products and determining the metallurgical losses. Besides the student will be required to keep a set of accounts of all the operations, to determine the profits and losses of the smelting operations and the costs of smelting the various ores.

S. ORE DRESSING.

Professor Austin and Mr. Copeland.

S 2. Ore Dressing.

Professor AUSTIN and Mr. COPELAND.

Two hours a week in class room and *three hours* in laboratory, sixteen weeks, winter term and first half of spring term. Also

twelve hours for excursions to neighboring mills and reports on the same. To count as four-tenths of a credit. To be preceded by W 2 (Mineralogy), and G 1 (Assaying).

The instruction in Ore Dressing will consist of recitations and laboratory practice, including:

(1) Breaking, crushing and concentrating of ores by stamps, rolls, gravity, and steam stamps, and other pulverizers. Laws of crushing.

(2) Concentrating or washing. Washers, screens, screen sizing, classifiers, hand picking, jigging. Sand and slime concentrators.

(3) Milling and amalgamation of gold and silver ores.

(4) Magnetic and ore separations.

(5) Mill processes and management, general ideas on milling.

The students are required to take samples and ascertain by fire or wet assay the degree of efficiency of the operations which they are conducting.

The student in mining engineering will find the ore dressing S 2 to be quite as essential as the metallurgy, since mining engineers, even if not metallurgists, are frequently called on to operate ore dressing or milling plants. The course also develops the methods of sampling, much needed in mining practice.

S 3. Practice Work in Ore Dressing.

Professor AUSTIN and Mr. COPELAND.

Forty-five hours a week, three weeks, first half of summer term. To count as five-tenths of a credit. To be preceded by S 2 (Ore Dressing) and Q 2 (Hydraulics).

The instruction in Ore Dressing will consist of recitations, excursions to ore dressing plants and practice at the Ore Dressing Mill, including:

(1) Breaking, crushing and concentrating of ores by stamps, rolls, and other pulverizers. Laws of crushing.

(2) Concentrating or washing. Washers, screens, screen sizing, classifiers, hand picking, jigging. Sand and slime concentrators.

(3) Milling and amalgamation of gold and silver ores.

(4) Mill processes and management, general ideas on milling.

The Ore Dressing Building is a wooden structure 81 by 30 feet.

It contains a Blake crusher, a Comet crusher, a pair of crushing rolls, a three stamp battery, a set (three) of trommels, two Hartz jigs, a Spitzkasten, a Frue Vanner, a Rittinger table, a Standard concentrator, a Calumet classifier, a Bridgman and Vezin sampler, and a sample grinder, together with minor machinery.

M. MECHANICAL ENGINEERING.

Professor Hood, Assistant Professor Christensen, Messrs. DeLay, McGrath, Johnson, Richards, Hamilton and Freeman.

The successful and economical operation of any mine depends so largely upon the judicious selection, proper design and skilful operation of the power plant and general machinery, that the College offers a course in mechanical engineering specially designed to prepare the student to take up such work.

The aim has been to so use those Mechanical Engineering subjects of special prominence in mining work as to give the student thorough training, and to indicate the methods of study and observation to be followed after graduation, should he decide to take up any branch of Mechanical Engineering as his specialty.

Throughout the whole course the attempt is made to present clearly the theory underlying each part of the work, and to fix and illustrate the theory by practical exercises in the shop, laboratory, draughting room, or reference to neighboring mine equipments.

Mechanical Engineering Building.

The workshops, mechanical laboratories, electrical engineering laboratories, and the draughting room, are located in the Mechanical Engineering Building.

Courses in the following subjects are offered:

M 1. Properties of Materials of Engineering.

Assistant Professor CHRISTENSEN.

General mechanical properties of metals; cast and wrought iron, steel, copper, brass and bronzes; lime, cement, concrete and brick; paints; timber and cordage; etc.

Three times a week, twenty-three weeks, fall and winter terms. To count as seven-tenths of a credit. To be preceded by B 1 (Physics) and F 1 (General Chemistry), and preceded by, or accompanied with B 4 (Physics).

The course includes a discussion of methods of manufacture of the more important materials (except such information as comes within the province of the course in Metallurgy); forms in which these materials appear in the market; their adaptation to the purposes of the engineer; methods of preserving materials from corrosion and decay, etc. Johnson's The Materials of Construction. The course is supplemented with practical work in testing, for details of which see M 6 (Testing Materials of Engineering).

M 2. Shop Practice.

Mr. McGrath, Mr. Johnson and Mr. Richards.

Shop practice is of value in giving intimate knowledge of the properties of materials, of the uses of machines for working them, and of the difficulties of attaining accuracy. Judgment in the use and selection of machinery is best trained in the shop. The skill acquired in the use of machines and tools may be of direct value, and is always of indirect value in giving familiarity and sympathy with such work. The course covers nine hours a day, except Saturday, for twelve weeks, summer term, and includes practice in wood and metal work. To count as two credits.

The practical instruction given is largely personal and each is advanced as rapidly as his proficiency will warrant. Recitations concerning the work are required. In the machine shop, practice is offered in bench and vise work, blacksmithing and with all of the usual machine tools. In the pattern shop, patterns are made of parts to be later completed in the machine shop. The course includes the use of wood-working bench tools and power machinery.

The shop is run as nearly like a producing shop as possible. Exercises for students are selected from parts of machines in course of actual construction and intended for use about the institution, as, crushing rolls, air compressors, rock drills, machine tools, etc. All work done in the shops is considered as the property of the college. No student is allowed work not assigned to him by the instructor.

Shop Equipment.

In addition to necessary work benches and hand tools, the shop contains—

One 24-inch by 16-foot New Haven Tool Co.'s lathe.
One 16-inch by 6-foot Lodge & Shipley lathe.
Two 14-inch by 5-foot Lodge & Shipley lathes.
Six 14-inch by 6-foot Reed lathes.
One 14-inch by 8-foot Reed lathe.
One 14-inch by 6-foot Lodge & Davis lathe.
One 13-inch by 5-foot Putnam lathe.
One 12-inch by 5-foot Prentis lathe.
One No. 2 Landis Grinder for hardened steel work.
One 24x24x8′ Whitcomb planer.
One 20x20x4′ Wm. Sellers & Co. planer.
One 16″ Gould & Eberhardt shaper.
One 10″ Traverse head shaper.
One 34″ Blaisdel drill press.
One 20″ Lodge & Davis drill press.
One sensitive drill.
One twist drill grinder.
One No. 1½ Cincinnati tool room milling machine.
Three emery tool grinders.
One buffing wheel.
One Power hack saw.
One 2-inch pipe and bolt machine.
One Arbor press.
One steam hammer.

The assortment of chucks, taps, drills, reamers and general tools is extensive. For practice in pipe fitting a separate bench has been provided; a complete set of pipe tools, and a supply of pipe and fittings up to two inches inclusive are in stock.

The blacksmith shop occupies a room 26 x 43 and is completely equipped with eight forges and the necessary hand and power tools.

The pattern shop contains ten wood lathes, a pattern maker's lathe to swing five feet, a 33-inch Fay band saw, a Beach jig saw, a 24-inch Fay hand planer and joiner, a 24-inch pony planer, Colburn universal saw bench, emery wheels and grindstones, gouge grinder, steam glue heaters, an extensive assortment of hand tools and appliances, and the necessary work-benches and vises.

croft oil tester, 2,000 lb. Olsen cement testing machine, with tools for tensile, compressive and transverse tests, briquette forming and cement mixing machines, and other measuring and testing devices.

Those having materials to be tested may make arrangements with the professor in charge of the department for tests.

M 9. Mechanical Engineering: Laboratory Practice.

Professor Hood and Assistant Professor Christensen.

Experimental work in the Mechanical Laboratory; determination of heating value of fuels; quality of steam; use of steam engine indicator; Prony brake, and other dynamometers; standardizing of indicators, steam gauges, etc.; valve setting, complete tests of engines, boilers and pumps, Carpenter's Experimental Engineering, Kent's Mechanical Engineer's Pocket Book. *Forty-five hours a week,* first six weeks of summer term. To count as one credit. Must be preceded by M 13 (Mechanical Engineering IV). This course is intended to give the student ample opportunity to verify practically the principles laid down in the preceding courses. Each student will be required to set up his own apparatus, and in many cases to design and build appliances for any special work on hand.

Equipment.

The power plant contains two Parker Steam Generators of 100 H. P. each, one 58 H. P. Stirling water-tube boiler, induced draft system, one 8x24 Reynolds Corliss engine, one 8x12 Buckeye engine in the dynamo room, a 13x12 Chandler & Taylor simple engine direct connected to a 3-phase generator, a 9x9 N. Y. safety vertical slide valve engine in the Ore Dressing building, a 5x5 horizontal slide valve engine, and one 50 H. P. Wheeler surface condenser, with Worthington air and circulating pump. Of the minor apparatus there is now in stock one Tabor indicator, and six Crosby indicators with electrical attachment, one Hine & Robertson indicator, one Collins continuous indicator, eight polar planimeters, ten of Green's standard thermometers for calorimetric work, calorimeters of the following kinds—barrel, continuous, superheating, throttling, and separator; Carpenter Coal Calorimeter, and Parr Calorimeter—one 15 H. P. Flather hydraulic dynamometer arranged for either transmis-

sion or absorption, Heath's stop-watch speed counter. Tabor speed counter, Schaeffer & Budenburg tachometer, pantographs, Hine & Robertson reducing motion, draught gauges. Ashcroft boiler test pump and gauge, gauges for use with water or steam, one gauge tester of the Ashcroft pattern, Ashcroft pyrometer, Bristol recording gauge, one Hancock ejector, a number of working injectors, with cut models of same, Buffalo scales of several patterns, Burnham, Worthington and Davidson pumps, Prony brakes, Deane and Marsh pumps, cut to show the interior mechanism, parts of various sectional boilers, etc.

By far the most important equipment consists of such apparatus as the kindness of various mines in the iron and copper district in the immediate neighborhood has placed at the service of the institution for testing. There are available for test some of the most extensive and interesting machinery to be found in any mining location, including hoisting engines, air compressors, pumps and boilers of many kinds. So far as possible these opportunities are used in preference to the college equipment.

M 10. Pumps and Pumping Machinery.

Professor Hood.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II.), and preceded by, or accompanied with C 2 (Analytic Mechanics).

Discussion of pump problems and of pump details, such as pistons, plungers, and methods of packing them; size of suction and delivery pipes, air and vacuum chambers, etc. Types of pumps—force pumps, crank and fly wheel, direct acting, duplex, compound and triple expansion pumps, fire, mine, rotary, centrifugal, and high duty pumps. Duty trials of pumps. Barr's Pumping Machinery, and lectures.

M 11. Mechanical Engineering II.

Professor Hood.

Fifteen hours a week, first five weeks of spring term. To count as three-tenths of a credit. To be preceded by M 5 (Mechanical Engineering I.), M 15 (Mechanical Drawing), M 1 (Properties of

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Draughting Room and Equipment.

The Draughting Room is 25 x 97 feet, with a 28 x 34-foot annex, containing instructors' offices, blue-print room, lavatory, etc. The room is on the north side of the building, thereby insuring freedom from shadows at any part of the day. It is provided with electric lights so arranged as to permit night work with the minimum of discomfort. The drawing tables provide each student with private lockers for his materials and a rack for board and T-square. There are sun and electric blue-printing equipments, etc. There are also cut models of pumps, injectors, valve gears, drawing of machinery, etc., used as illustrative material.

M 16. Machine Drawing.

Messrs. DeLay, Hamilton and Freeman.

Fifteen hours a week, eleven weeks, winter term. To count as six-tenths of a credit. To be preceded by M 15 (Mechanical Drawing).

Making of complete working drawings of various details of machine construction from drawings, sketches of models. Tracing and blue-printing. Anthony's Machine Drawing.

N. ELECTRICAL ENGINEERING.

Professor Hood and Mr. DeLay.

The rapid development of electrical methods as applied to a wide field of mining practice in lighting, power transmission, and metallurgical manipulation, makes a broad knowledge of the principles of electricity necessary to the well-equipped mining engineer. A study of electrical engineering, both fixes these principles and gives some familiarity with current engineering practice. Such subjects as are of special prominence in mining are naturally accentuated here. The courses outlined are as follows:

N 1. Electrical Engineering.

Mr. DeLay.

An introductory course presenting dynamo and motor construction, transformers, secondary batteries, lamps, etc., and questions concerning their selection, installation, care and wiring for light and

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power. Electrical Engineering by Rosenberg, Gee and Kinzbrunner, and Badt's Incandescent Wiring Hand-Book. *Three times a week,* twenty-three weeks, fall and winter terms. To count as seven-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and preceded by, or accompanied with B 3 (Electrical Measurements).

N 3. Electrical Engineering: Laboratory Practice.

Professor Hood and Mr. De Lay.

Experimental work in the Electrical Laboratory, having for its object the familiarizing of the student with the general construction, running and testing of the common forms of electrical apparatus used in lighting and power transmission. The laboratory affords practice with direct, alternating and polyphase currents, incandescent and arc lighting, and motors on constant potential, constant current and polyphase circuits.

The equipment includes two direct current dynamos with four motors. A 33 K. W., 1,000 Volt, alternating current machine. One 70 K. W. and one 15 K. W. three-phase generator with several motors. Two arc light machines, one constant current motor, a 60 Cell Storage Battery, all with suitable switch board, instruments, transformers and laboratory measuring instruments.

Forty-five hours a week, second six weeks of summer term. To count as one credit. To be preceded by N 1 (Electrical Engineering).

Q. CIVIL ENGINEERING.

Professor Sperr, and Messrs. Baxter, Schubert, Meuche, Rose and—.

Q 1. Surveying (Field Work).

Professors Sperr, and Messrs. Baxter, Schubert, Rose and —

Fifty hours a week, twelve weeks, summer term. Beginning about the first of June each year. To count as two and two-tenths credits. To be preceded by A 3 (Spherical Trignometry) and Q 4 (Topographical Drawing), except that persons of experience, who

Maps are required to be made of the mining claim pacing survey, the mining claim official survey, the azimuth and repetition traverse surveys, the farm survey, the stadia survey, the city survey, and the railroad survey.

The class is divided into squads, with just a sufficient number in the squad to do the required work. By rotation each member of the class is required to do every different kind of work with every different instrument used, make a full set of notes of the work done by his squad, and from these notes make the maps in the drawing room.

The equipment for instruction comprises the following set of instruments:

Five Buff & Berger transits.
Four C. L. Berger & Sons transits.
Three Heller & Brightly transits.
Two Fauth & Co. transits.
Five W. & L. E. Gurley transits.
One Mahn & Co. transit.
Two Buff & Buff transits.
Eight W. & L. E. Gurley Engineer's levels.
Three Heller & Brightly Engineer's levels.
One Buff & Berger Engineer's levels.
Two C. L. Berger & Sons Engineer's levels.
One Buff & Berger plane table.
One C. L. Berger & Sons plane table.
Two W. & L. E. Gurley plane tables.
Five W. & L. E. Gurley Burt solar compasses.
Seven W. & L. E. Gurley Surveyor's compasses.
Five Brunton pocket mine transits.
Ten water levels.
Forty-eight Locke hand levels.

In addition to these more expensive instruments the College owns the necessary number of chains, steel tapes, poles, rods, etc.

The furnishing of the Surveying apparatus by the College is a heavy expense to the institution, and while losses due to ordinary and legitimate wear and tear of the instruments are borne by the College, any injuries due to carelessness on the part of the student must be made good by him.

Every student is required to provide himself with a steel pocket tape graduated to feet and tenths, and not less than 25 feet long, a pocket compass, a reading lens, a wood ax, a timber pencil, a field book, and drawing instruments as in Q 4 (Topographical Drawing).

Text books: Theory and Practice of Surveying, Johnson; Field Engineering, Searle.

Q 2. Hydraulics.

Mr. BAXTER.

Three times a week, sixteen weeks, winter and first half of spring term. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining), and preceded by, or accompanied with A 5 (Calculus).

Recitations and problems on the following:

1. Hydrostatics.
2. Theoretical hydraulics.
3. Flow through orifices.
4. Flow over weirs.
5. Flow through tubes.
6. Flow in pipes.
7. Flow in conduits and canals.
8. Flow in rivers.
9. Measurement of water power.
10. Dynamic pressure of flowing water.
11. Water wheels.
12. Turbines.

Text Book: Treatise on Hydraulics, Merriman.

Q 3. Hydraulics.

Professor SPERR and Mr. BAXTER.

Two hours a week in lecture room and *seven hours* in laboratory, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by Q 2 (Hydraulics) and M 5 (Mechanical Engineering I.).

The Hydraulic Laboratory is provided with two main reservoirs, —a steel supply reservoir of 18.000 gallons capacity in the tower of

the building, and a reservoir below in the form of a canal of 25,000 gallons capacity, giving a head of about 90 feet. The discharge from the supply reservoir is through a 10-inch stand pipe, which may be drawn from at the different floors in the tower by nine 10-inch Fairbanks gate valves. Galvanized iron conduits pass the entire length of the tower and are so arranged as to conduct the flow into the reservoir below or into large weighing tanks at will.

The main part of the laboratory is sixteen feet in the clear, with balcony around for accommodation of light appliances. Also passing around this part are mains as follows: A 6-inch water supply, a 6-inch pump discharge (into supply reservoir or weighing tanks), a 2½-inch steam supply, a 3-inch steam exhaust (into atmosphere or surface condenser), and along the north balcony, a 6 x 12-inch conduit to a pair of hanging tank scales. Steam and electricity are furnished by the central Power Plant operated by the Mechanical Department.

A complete electrical signal and telephone system is in operation, consisting of fixed and portable sets so arranged that communication may be had between any two or more points in the Main Laboratory or Tower.

The following apparatus is now available for experimental work:

One 5½ x 3½ x 5 Snow duplex steam pump.

One 8 x 8½ x 12 Snow duplex steam pump.

One 6 x 12 Deane triplex electric pump with 7 H. P. induction motor and Reeves speed regulator.

One 12-inch Morris centrifugal pump.

One Evans hydraulic gravel elevator, with sluices, undercurrent and riffles.

One Evans hydraulic giant.

One 20-inch Pelton water motor.

One 15-inch Tuthill water motor.

One Doble water motor with glass covers.

One 8-inch Leffel turbine.

One Worthington water meter.

One Price acoustic current meter.

One orifice tank for low heads.

Two Buffalo platform tank scales, each 20,000 lbs. capacity.

Two Buffalo hanging tank scales, each 3,560 lbs. capacity.

Two Buffalo platform scales, each 2,560 lbs. capacity.

One Buffalo laboratory scales of 400 lbs. capacity, and sensitive to 1/100 of a pound.

One 5 H. P. electric induction motor for driving line shaft.

Six valve orifice plates of special design, with orifices interchangeable from the outside and without loss of water.

In the laboratory are also numerous orifices and weirs of various shapes and sizes, steam, water, mercury, and hook guages; speed indicators, steam indicators, and other apparatus necessary for determining the efficiency and coefficients of the various hydraulic appliances used in connection with mining operations. One or more trips may be made to hydraulic works in the vicinity.

Text Books:

Treatise on Hydraulics, Merriman.
Notes and Library References.

Q 4. Topographical Drawing.

Mr. Meuche.

Fifteen hours a week, five weeks, last five weeks of spring term. To count as three-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). This subject is required for the summer course in Surveying (Q 1). The course is given by lectures and individual instruction in the Drawing Room on the following:

I. Making Titles, Scales, Borders, etc.
II. Traversing.
III. Plotting.
  1. By Protraction.
  2. By Rectangular Co-ordinates.
IV. Computing.
  1. Areas.
  2. Volumes.
V. Topography.
  1. Topographical Signs.
  2. Topographical Maps.

Instruments Required.

One 5-inch right line pen.
One swivel curve pen.
One 5½-inch compass (pivot joint) with hair spring, pen, pencil, points and extension bar.
One 3¼-inch bow pen.
One 3¼-inch bow pencil.
One 3¼-inch bow dividers.
One protractor.
One 12-inch triangular decimal scale.
One 10-inch 30 x 60-degree amber triangle.
One 9-inch 45-degree amber triangle.
One-half dozen thumb tacks.
One bottle Higgins' black *water-proof* drawing ink.
One bottle Higgins' carmine drawing ink.
One rubber pencil eraser.
One ink eraser.
One sponge rubber.
One 6H. pencil.
One piece chamois skin, about 12 x 8 inches.
One-half pan each, moist colors, as follows: Prussian blue, burnt sienna.
Two No. 1 Spencerian pens, with holder.
Two mapping or crow quill pens, with holder.
Two ball pointed pens.

All instruments must be of first-class quality. Students will not be allowed to work with inferior instruments. Articles in the above list may be purchased by students at the College.

Text Books:

A System of Free-hand Lettering, Reinhardt.
The Theory and Practice of Lettering, Sherman.
Theory and Practice of Surveying, Johnson.

Q 5. Surveying (Office Work).

Mr. Meuche.

Ten hours a week for eleven weeks, winter term. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying).

In this course the objects and purposes of the field and railroad surveying are more fully developed,—new points are taken up in the text by lecture and recitation, and practice is given in the drawing room involving methods and instruments used in the surveyor's office.

Text Books:

Notes and Library References.
The Theory and Practice of Surveying, Johnson.

Q 6. Graphical Statics.

Messrs. SCHUBERT and ROSE.

Twelve hours a week (one lecture, two recitations and nine hours in drawing room), twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics), and M 15 (Mechanical Drawing).

This subject is designed to teach the theory of the graphical analysis of stresses in structures, under the action of steady and moving loads, and the pressure of the wind. For example, the solution of a certain class of roof trusses is taken up in the lecture. The student is assigned a number of preblems on the different types of trusses in this class, to be solved in the drawing room by aid of the text book and such individual instruction as may be necessary. For this problem he would be required to report the nature and value of the stress in each member of the truss under the various loads specified, each student being given different conditions and data.

Text Book:

Graphical Analysis of Roof Trusses, Greene.

Q 7. Engineering Design and Construction.

Professor SPERR and Mr. MEUCHE.

Twelve hours a week, sixteen weeks, winter and first half of spring terms. To count as seven-tenths of a credit. To be preceded by M 15 (Mechanical Drawing), Q 6 (Graphical Statics), and pre-

Instruments Required.

One 5-inch right line pen.
One swivel curve pen.
One 5½-inch compass (pivot joint) with hair spring, pen, pencil, points and extension bar.
One 3¼-inch bow pen.
One 3¼-inch bow pencil.
One 3¼-inch bow dividers.
One protractor.
One 12-inch triangular decimal scale.
One 10-inch 30 x 60-degree amber triangle.
One 9-inch 45-degree amber triangle.
One-half dozen thumb tacks.
One bottle Higgins' black *water-proof* drawing ink.
One bottle Higgins' carmine drawing ink.
One rubber pencil eraser.
One ink eraser.
One sponge rubber.
One 6H. pencil.
One piece chamois skin, about 12 x 8 inches.
One-half pan each, moist colors, as follows: Prussian blue, burnt sienna.
Two No. 1 Spencerian pens, with holder.
Two mapping or crow quill pens, with holder.
Two ball pointed pens.

All instruments must be of first-class quality. Students will not be allowed to work with inferior instruments. Articles in the above list may be purchased by students at the College.

Text Books:

A System of Free-hand Lettering, Reinhardt.
The Theory and Practice of Lettering, Sherman.
Theory and Practice of Surveying, Johnson.

Q 5. Surveying (Office Work).

Mr. Meuche.

Ten hours a week for eleven weeks, winter term. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying).

In this course the objects and purposes of the field and railroad surveying are more fully developed,—new points are taken up in the text by lecture and recitation, and practice is given in the drawing room involving methods and instruments used in the surveyor's office.

Text Books:

Notes and Library References.
The Theory and Practice of Surveying, Johnson.

Q 6. Graphical Statics.

Messrs. Schubert and Rose.

Twelve hours a week (one lecture, two recitations and nine hours in drawing room), twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics), and M 15 (Mechanical Drawing).

This subject is designed to teach the theory of the graphical analysis of stresses in structures, under the action of steady and moving loads, and the pressure of the wind. For example, the solution of a certain class of roof trusses is taken up in the lecture. The student is assigned a number of preblems on the different types of trusses in this class, to be solved in the drawing room by aid of the text book and such individual instruction as may be necessary. For this problem he would be required to report the nature and value of the stress in each member of the truss under the various loads specified, each student being given different conditions and data.

Text Book:

Graphical Analysis of Roof Trusses, Greene.

Q 7. Engineering Design and Construction.

Professor Sperr and Mr. Meuche.

Twelve hours a week, sixteen weeks, winter and first half of spring terms. To count as seven-tenths of a credit. To be preceded by M 15 (Mechanical Drawing), Q 6 (Graphical Statics), and pre-

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Text Book:

Ore and Stone Mining, Foster.

R 2. Mine Surveying and Mining (Classroom Work).

Professor Sperr and Mr. Baxter.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by Q 1 (Surveying) and R 1 (Principles of Mining).

OUTLINE OF THE SUBJECT.

I. MINE SURVEYING.

1. Definition.
2. Objects and Purposes.
3. Maps Required.
4. Instruments Used.
5. Adjustment of the Transit.
   a. Adjustment of the Side Telescope.
   b. Adjustment of the Top Telescope.
6. The Reference Line.
7. Connection of the surface with the underground survey through an inclined shaft or slope.
   a. Form of Notes.
   b. Problems.
8. Connection of the surface with the underground survey through a vertical shaft.
   a. With the Transit.
   b. By means of Plumb Lines.
9. Methods of Traversing Underground.
10. Surveying of Coal Mines.
    a. Putting up Sights.
    b. Taking up Rooms, etc.
11. Determination of Strike and Dip.

II. MINING.

1. Coal Mining.
   a. Prospecting the Property.
   b. Locating the Shaft, Slope or Drift.
   c. Laying out the Mine.

2. Iron Ore Mining.
   a. Prospecting the Deposit.
   b. Locating the Shaft.
   c. Laying out the Mine.
3. Mine Timbering.
   a. Drifts and Levels.
   b. Stopes.
   c. Raises and Chutes.

The instruction is given from private notes and from references to professional papers to be found in the College library.

R 3. Mine Surveying and Mining (Field Work).

Professor SPERR and Messrs. BAXTER, SCHUBERT, ROSE and HARTNESS.

Fifty-four hours a week, five weeks, last half of spring term. To count as one credit. To be preceded by R 2 (Mine Surveying and Mining), except for students who enter for this subject only, who are required to be prepared in Algebra, Trigonometry, and in the use of the transit and level.

The first two weeks are devoted to surveying and mapping a mine or some portion thereof, in some one of the iron mining districts of Northern Michigan. The last three weeks are devoted to the examination of mining methods in the iron ore mines. Sketches are made of the plans of the mines to show methods of laying out; of cross-sections to show methods of stoping; of timber structures to show methods of framing; of the timbering set up in drifts and stopes; of the tramming, hoisting and general handling arrangements; of ore-chutes, ore pockets, etc.

R 4. Mining Engineering.

Professor SPERR.

Three times a week, sixteen weeks, winter and first half of spring term. To count as five-tenths of a credit. To be preceded by C 2 (Analytic Mechanics), R 3 (Mine Surveying and Mining) and Q 2 (Hydraulics), and preceded by or accompanied with M 4 (Mechanics of Materials).

tals, necessary for teaching this subject. To be preceded by or accompanied with W 4 (Elementary Mineralogy and Crystallography).

Elements of Crystallography, by G. H. Williams, is used as a text book in this subject.

W 2. Mineralogy.

Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

Twelve hours a week, sixteen weeks, winter and first half of spring terms. To count as seven-tenths of a credit.

Students taking this course are required to provide themselves with A System of Mineralogy, by J. D. Dana, and lecture notes by Professor Seaman.

Individual work is one of the features of this course. Each student is required to work out an assigned lot of minerals, and personally recite to an instructor. In these recitations he is required to point out the particular physical characters by which he recognizes his minerals. He must be able to give the chemical composition, orientate the crystal form, and cleavage, and describe the other physical properties that exist. Each student in this course must become familiar with more than two hundred mineral species so that he can either recognize them at sight, or at least after he has applied a few simple field tests, such as hardness, fracture, cleavage, etc.

This subject must be preceded by B 1 (Physics), F 2 (Blowpipe Analysis), W 1 (Crystallography), and Y 1 (Principles of Geology).

W 3. Advanced Mineralogy.

Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

Six hours a week, twenty-three weeks, fall and winter terms. To count as five-tenths of a credit.

This course will be offered only to students who are specializing in Geology, and are taking the advanced Petrography (X 2).

Some of the rare minerals will be studied, as well as some of the less important ores. The products of alteration will be studied more in detail than in the preceding courses. Thermo-electricity, radio-activity and other physical characters not treated in the regu-

lar course, will be discussed and exemplified. About one hundred mineral species not given in the other courses will be studied in some detail.

To be preceded by W 2 (Mineralogy) and accompanied with X 2 (Advanced Petrography).

W 4. Elementary Mineralogy.

Professor SEAMAN, and Messrs. COREY, BOWEN and HANCOCK.

Fourteen hours a week, twelve weeks, fall term, and *three hours a week,* sixteen weeks, winter and first half of spring terms. To count as eight-tenths of a credit.

The first four weeks of the fall term will be devoted to crystal study. The last eight weeks will then be given to the study of ore-forming and rock-forming minerals. Only the more common important minerals will be studied in this course. Each student will be required to become familiar with at least fifty mineral species.

In the winter and spring terms the students will be instructed in the classification and determination of rocks, the object of the course being to give the student a sufficient knowledge of rocks and minerals to enable him to comprehend his work in Principles of Geology.

X. PETROGRAPHY.

Mr. Corey and Mr. Bowen.

X 1. Petrography.

Messrs. COREY and BOWEN.

Nine hours a week, twenty-eight weeks, fall, winter, and first half of spring terms. To count as eight-tenths of a credit. To be preceded by Y 1 (Principles of Geology), and preceded by, or accompanied with B 5 (Light) and W 4 (Elementary Mineralogy and Crystallography).

The work is divided into two parts: Microscopic Mineralogy and Lithology.

A. Microscopic Mineralogy: Under this head are treated the optical and physical characters of minerals, as revealed by the microscope. Especial attention is directed to those characters by which the minerals may be recognized as rock constituents. The alter-

ations of the minerals are studied with care, owing to the importance of these in the subject of Economic Geology.

B. Lithology: The instruction in this branch of Petrography comprises both the macroscopic and microscopic study of rocks. For this work large and complete collections of rock specimens with thin sections are arranged for the use of the student. The lectures are illustrated by typical hand specimens; also by thin sections projected on a screen by means of a large projecting microscope. Special attention is called to the variations in rocks and to their local modifications due to their special mode of occurrence in the field.

The course is made thorough and practical, every student receiving personal instruction and being required to recite on a large number of hand specimens, and write accurate petrographic descriptions of specimens from various localities.

X 2. Advanced Petrography.

Messrs. Corey and Bowen.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

This course will consist of a detailed study of the rocks of some assigned locality. Each student is required to make a complete and thorough petrographic report on a group of rocks. Determinations are made of physical, optical and crystallographic constants of rock-making minerals. The relations of the alterations of rocks to ore deposition are taken up more fully than in the course X 1 (Petrography). To be preceded by X 1 (Petrography), and acompanied with W 3 (Mineralogy).

Y. GEOLOGY.

Professor Seaman, and Messrs. Corey, Bowen and Hancock.

Y 1. Principles of Geology.

Professor Seaman and Messrs. Corey and Bowen.

Two times a week, twelve weeks, fall term, *one time a week,* sixteen weeks, winter and first half of spring terms. To count as four-tenths of a credit. An elementary text-book will be used in this course. No student will be given credit in this course until he has completed W 4 (Elementary Mineralogy and Crystallography).

Y 2. Historical Geology.

Professor SEAMAN and Mr. HANCOCK.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in this study will consist of recitations and laboratory work, and will be given following V 2. The main object of the course will be to familiarize the student with the life history of the earth, and with the lithological character, order of superposition, periods of upheaval, and the areal distribution of the formations which compose the earth's crust.

There will be laboratory drill in assigning fossils to their proper geological period. In this work the students will have access to palæontological literature, with which the library is well supplied, and will be required to prepare palæontological charts to facilitate their work. The material at present accessible for the laboratory work consists of a palæontological collection of about eight thousand specimens, three small rock collections, one European and two American, containing six hundred specimens, arranged stratigraphically, and over one thousand specimens of sedimentary rocks representing the geological column.

In addition to the above, some time will be given to surface geology, in which the present contours of the earth's surface will be discussed.

The text book used is An Introduction to Geology, by W. B. Scott, supplemented by the use of the correlation papers and other publications and maps of the U. S. Geological Survey. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology).

Y 3. Physical and Chemical Geology.

Professor SEAMAN and Mr. COREY.

Three times a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in Physical Geology is intended to be especially adapted to the needs of the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman, and all others

ations of the minerals are studied with care, owing to the importance of these in the subject of Economic Geology.

B. Lithology: The instruction in this branch of Petrography comprises both the macroscopic and microscopic study of rocks. For this work large and complete collections of rock specimens with thin sections are arranged for the use of the student. The lectures are illustrated by typical hand specimens; also by thin sections projected on a screen by means of a large projecting microscope. Special attention is called to the variations in rocks and to their local modifications due to their special mode of occurrence in the field.

The course is made thorough and practical, every student receiving personal instruction and being required to recite on a large number of hand specimens, and write accurate petrographic descriptions of specimens from various localities.

X 2. Advanced Petrography.

Messrs. COREY and BOWEN.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

This course will consist of a detailed study of the rocks of some assigned locality. Each student is required to make a complete and thorough petrographic report on a group of rocks. Determinations are made of physical, optical and crystallographic constants of rock-making minerals. The relations of the alterations of rocks to ore deposition are taken up more fully than in the course X 1 (Petrography). To be preceded by X 1 (Petrography), and acompanied with W 3 (Mineralogy).

Y. GEOLOGY.

Professor Seaman, and Messrs. Corey, Bowen and Hancock.

Y 1. Principles of Geology.

Professor SEAMAN and Messrs. COREY and BOWEN.

Two times a week, twelve weeks, fall term, *one time a week,* sixteen weeks, winter and first half of spring terms. To count as four-tenths of a credit. An elementary text-book will be used in this course. No student will be given credit in this course until he has completed W 4 (Elementary Mineralogy and Crystallography).

Y 2. Historical Geology.

Professor SEAMAN and Mr. HANCOCK.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in this study will consist of recitations and laboratory work, and will be given following V 2. The main object of the course will be to familiarize the student with the life history of the earth, and with the lithological character, order of superposition, periods of upheaval, and the areal distribution of the formations which compose the earth's crust.

There will be laboratory drill in assigning fossils to their proper geological period. In this work the students will have access to palæontological literature, with which the library is well supplied, and will be required to prepare palæontological charts to facilitate their work. The material at present accessible for the laboratory work consists of a palæontological collection of about eight thousand specimens, three small rock collections, one European and two American, containing six hundred specimens, arranged stratigraphically, and over one thousand specimens of sedimentary rocks representing the geological column.

In addition to the above, some time will be given to surface geology, in which the present contours of the earth's surface will be discussed.

The text book used is An Introduction to Geology, by W. B. Scott, supplemented by the use of the correlation papers and other publications and maps of the U. S. Geological Survey. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology).

Y 3. Physical and Chemical Geology.

Professor SEAMAN and Mr. COREY.

Three times a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in Physical Geology is intended to be especially adapted to the needs of the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman, and all others

ations of the minerals are studied with care, owing to the importance of these in the subject of Economic Geology.

B. Lithology: The instruction in this branch of Petrography comprises both the macroscopic and microscopic study of rocks. For this work large and complete collections of rock specimens with thin sections are arranged for the use of the student. The lectures are illustrated by typical hand specimens; also by thin sections projected on a screen by means of a large projecting microscope. Special attention is called to the variations in rocks and to their local modifications due to their special mode of occurrence in the field.

The course is made thorough and practical, every student receiving personal instruction and being required to recite on a large number of hand specimens, and write accurate petrographic descriptions of specimens from various localities.

X 2. Advanced Petrography.

Messrs. COREY and BOWEN.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

This course will consist of a detailed study of the rocks of some assigned locality. Each student is required to make a complete and thorough petrographic report on a group of rocks. Determinations are made of physical, optical and crystallographic constants of rock-making minerals. The relations of the alterations of rocks to ore deposition are taken up more fully than in the course X 1 (Petrography). To be preceded by X 1 (Petrography), and acompanied with W 3 (Mineralogy).

Y. GEOLOGY.

Professor Seaman, and Messrs. Corey, Bowen and Hancock.

Y 1. Principles of Geology.

Professor SEAMAN and Messrs. COREY and BOWEN.

Two times a week, twelve weeks, fall term, *one time a week,* sixteen weeks, winter and first half of spring terms. To count as four-tenths of a credit. An elementary text-book will be used in this course. No student will be given credit in this course until he has completed W 4 (Elementary Mineralogy and Crystallography).

Y 2. Historical Geology.

Professor SEAMAN and Mr. HANCOCK.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in this study will consist of recitations and laboratory work, and will be given following V 2. The main object of the course will be to familiarize the student with the life history of the earth, and with the lithological character, order of superposition, periods of upheaval, and the areal distribution of the formations which compose the earth's crust.

There will be laboratory drill in assigning fossils to their proper geological period. In this work the students will have access to palæontological literature, with which the library is well supplied, and will be required to prepare palæontological charts to facilitate their work. The material at present accessible for the laboratory work consists of a palæontological collection of about eight thousand specimens, three small rock collections, one European and two American, containing six hundred specimens, arranged stratigraphically, and over one thousand specimens of sedimentary rocks representing the geological column.

In addition to the above, some time will be given to surface geology, in which the present contours of the earth's surface will be discussed.

The text book used is An Introduction to Geology, by W. B. Scott, supplemented by the use of the correlation papers and other publications and maps of the U. S. Geological Survey. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology).

Y 3. Physical and Chemical Geology.

Professor SEAMAN and Mr. COREY.

Three times a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The instruction in Physical Geology is intended to be especially adapted to the needs of the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman, and all others

who desire to understand the connection and the structural relations that rock masses have to one another and to the valuable deposits which they may contain. It treats of the origin and alterations of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, cleavage, mountain building, eruptive rocks and crystalline schists; the action of air, surface and underground waters, and life; the interior condition of the earth, etc., especially in their relations to the problems that the economic geologist, miner and quarryman have to meet. The student has brought before him constantly the various problems that arise in practical work and the methods of their solution.

This course enlarges and completes much that is briefly touched upon in the Principles of Geology and in Petrography.

The text book used is Dr. Archibald Geikie's Text Book of Geology, fourth edition, 1903, books I, II, III, IV and VII.

Students who take this subject must have completed W 2 (Mineralogy), and X 1 (Petrography) must precede or accompany this subject.

Y 4. Geological Field Work.

Professor SEAMAN and Messrs. COREY and BOWEN.

Forty-five hours a week for the last six weeks of the summer term. To count as one credit. The instruction in this subject begins about the middle of July, and consists of six weeks' practical work in the field. The work is practically confined to the Pre-Cambrian rocks of the Lake Superior region.

A few days of the course are spent at compass work, in which the student is trained in the use of the dial and dip compasses and aneroid barometer. This work consists of running section lines, meandering roads and streams, and platting outcrops; in fact, making a complete map of the traverse. Specimens are collected and located with reference to some monument established by the United States linear survey. The student plats all of his work in the field, keeping his latitude and departure by means of his compass course and pacing.

After the students become more or less adept at platting and compass work they are given small special areas to map in detail, and to work out the relations of the rocks. They make sections and

plans showing these relations, and are required to write descriptions of the specimens collected, and to explain the geological phenomena observed.

Considerable time is spent in the study of the older granites, gneisses and hornblende schists, etc., with their varied accompaniment of tuffs and basic and acid intrusives which comprise the basement complex. Here the various acid and basic dike rocks are studied in their relation to one another and to the older schists. Vein phenomena are also studied at the various openings along the gold range northwest of Ishpeming.

Most of the time is spent in studying the "Algonkin" clastics that rest unconformably upon the older Basement Complex. These clastics in the Marquette Iron-Bearing District are found to be capable of division into a lower, a middle and upper series, termed respectively the "Lower Marquette," "Middle Marquette" and the "Upper Marquette" series. These series are separated from each other by unconformities. Large bodies of iron ore are associated with the middle and upper series. The ore bodies are studied with reference to their origin, and maps and sections are made showing their mode of occurrence, and their relation to the associated rocks.

The department is well equipped with the instruments necessary for this work, and note books with special rulings are furnished the students at cost.

All students entering the college for instruction in this subject (Y 4) only, should have a fair knowledge of Mineralogy, Lithology and General Geology, if they wish to fully profit by the course. The other students at the College who are candidates for degrees, in order to take this subject are required to have passd in Q 1 (Surveing) and Y 2 (Historical Geology).

Y 5. Economic Geology.

Mr. Bowen.

Three times a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. Prerequisites, W 3 (Mineralogy), X 2 (Petrography), Y 4 (Field Geology). The course includes a discussion of the genesis of ore-deposits and a careful consideration of the useful metallic and non-metallic minerals; the deposits of the United States receive especial

consideration. Foreign occurrences are treated as time will permit.

The aim is to make the course as practical as possible. To this end the uses, mode of occurrence, distribution, origin, technology and facts which bear upon the commercial value of ores and minerals are especially considered.

Students are required to make abstracts of professional and technical reports for presentation before the class. All students are held responsible for a knowledge of the data given in such report.

The laboratory is well equipped with material representative of the subject from the United States and foreign countries. Students are required to spend sufficient time in the laboratory to thoroughly familiarize themselves with this material.

J. THESIS.

The Faculty.

J 1. Thesis.

Properly qualified students may include the preparation of a thesis in their work for a degree. To count as one credit.

The subject of such thesis must be announced with the schedule of studies for the year in which the degree is expected; further, the schedule must be approved by the head of the department in which the thesis work is to be done. This approval will include the subject chosen and the student's preparation to do the work.

The schedule and subject are then considered by the Faculty, whose approval is necessary.

The thesis must be completed by July 1, and submitted to the Faculty for examination and acceptance. For its acceptance it must be accompanied with a written approval of the instructors under whom the work was done.

PHYSICAL TRAINING

Mr. Stewart.

No argument is needed to establish the proposition that one who desires to do his best work must take reasonable care of his health. High grade intellectual work is dependent on physical condition and it is the part of wisdom to make provision for the maintenance

of good health. Nature has decreed that one of the factors on which health shall depend is a reasonable amount of exercise. Where this is not supplied by the individual's occupation it must be obtained by means of athletic games and sports, indoors and out.

The life of the student at the College of Mines is very like that of the business man busy with affairs, and the need of rational physical exercise and mental relaxation is correspondingly great. This fact is recognized and provision is made in the new Gymnasium and Club House for the best kinds of exercise and recreation serving to relax the mind and renew the body, making both more fit for the business in hand.

The class work which is quite informal consists of light all around exercise. Those desiring to specialize in some particular line are given opportunity to do so. Recreative games are made a prominent feature, sport for sport's sake being the rule. Use is made of the facilities afforded in the building for social intercourse. Here the students are afforded opportunity to meet and get acquainted with each other outside of the classroom and also opportunity to meet people of the vicinity not connected with the College.

It is confidently expected that the activities centering in the Gymnasium and Club House will add largely to the pleasure of the life of the students and will increase the efficiency of their college work. Instead of finishing the college course with less of physical power than at the beginning, it is expected that they will gain physical vigor as well as mental and be therefore so much better fitted to take up difficult work on graduation.

Classes five afternoons and three evenings each week throughout the year. Open to all students.

Special instruction in all branches of Gymnastics, Athletics and Games will be given by appointment. The instructor will consult with all who desire his advice on matters of health, physical development and corrective exercises taking such measurements and tests and prescribing such special exercise and treatment as the case may require.

DEGREES

The approximate unit of credit is assumed to be three hours a week in the class room (approximately nine hours of total work) or nine hours a week in the laboratory for thirty-three weeks. A subject scheduled for more or less time than here indicated takes its proportionate credit. No partially completed course may be accepted for credit either in whole or in part. The College is in session for four terms each year. It is therefore possible for a properly prepared student to cover the ordinary twelve term or four years engineering course in three calendar years.

Three degrees are offered by the College as follows:

Bachelor of Science, B.S.

Engineer of Mines, E.M.

Doctor of Philosophy, Ph.D.

The conditions under which the first two are given are as follows:

To obtain either degree the candidate must have been a resident student of this institution for at least one full year of forty-five weeks.

All candidates for the degree of Bachelor of Science are required to obtain twenty credits, including subjects R 1 (Principles of Mining), W 4 (Elementary Mineralogy and Crystallography), and Y 1 (Principles of Geology).

All candidates for the degree of Engineer of Mines are required to obtain twenty-five credits, including subjects R 1 (Principles of Mining), W 4 (Elementary Mineralogy and Crystallography), and Y 1 (Principles of Geology).

All students who have been granted the degree of Engineer of Mines may obtain the Bachelor of Science degree on payment of the required fee.

All students who graduated from this institution prior to 1896, with the degree of Bachelor of Science, may receive the degree of Engineer of Mines, on the presentation of evidence showing five years of subsequent successful practical work, submitting a satisfactory thesis, and paying the required fee.

The degree of Ph.D. will be given under the following conditions:

A student who has received the degree of Engineer of Mines from the Michigan College of Mines, or who is a graduate of another institution of similar grade, whose courses are approved by the Facutly, may be admitted as a candidate for the degree of Doctor of Philosophy. In order to attain this degree he must pursue, for at least two years, advanced study in subjects allied to the work of this institution, which subjects are approved by the Faculty.

One of the years may, in special cases, be spent elsewhere, and the work may be accepted, on sufficient proof of its thoroughness and high character, as the equivalent of one year's work done here. But under no condition will this degree be given to anyone unless at least one year of forty-five weeks of actual work be done by him as a resident student in this institution.

Students who have received the degree of Engineer of Mines from this College, or who are graduates of an equivalent professional school, and who are also arts graduates of some college or university whose course of study is accepted by the Faculty, may be admitted to the degree of Doctor of Philisophy, after having taken, for at least one year of forty-five weeks, an approved course of study at this institution.

The degree of Doctor of Philosophy will be given only in case the candidate shall have shown marked ability and power in original investigation, and his thesis shall have received the approval of the Faculty.

Fees.

Bachelor of Science	$15 00
Engineer of Mines	25 00
Doctor of Philosophy	50 00

No degree will be conferred until the required fee has been paid, which payment must be made to the Treasurer prior to August 15.

EMPLOYMENT

To one contemplating entering upon training for any particular profession, the question, will it pay? is one of deep and often of disproportionate interest. In reference to a Mining Engineering training this question generally resolves itself into more specific inquiry; what are the chances of obtaining a position upon graduation? Regarding this question it may be said that, with the increasing interest in mines and mining, in this and other countries, the demand for competent mining men is on the increase, and at the present time it seems that Mining Engineering offers opportunities at least as wide as are offered by any other line of engineering.

It should be clearly understood that the Michigan College of Mines makes no promise whatever to secure positions for its graduates. Upon graduation each man goes into the market to sell his services, meeting the same conditions as every other technical graduate in mining, whether prepared at this or another college. At the same time the College takes an interest in its graduates. Each one is urged to keep the institution informed of his whereabouts, his work, and whether or not he desires a change. From information thus gained a record is made and kept as nearly up to date as possible. When the College is asked to recommend a man for a given position, this record is looked over and the most available man is selected from it. In no case is a man recommended merely because he is a graduate of this institution. In selecting him his experience, his character and his general ability, both as shown in his work as a student and in his career after he leaves College, are taken into account. His defects, if known, are stated as carefully as are his aptitudes or excellencies, and no one is recommended unless he is deemed fit for the position.

Prospective students and those responsible for them should understand that the College cannot impart traits of character. The best it can do is to help the student develop properly those character-

istics which he already possesses. His advancement in his profession will depend quite as much upon his character and ability as upon his technical training, whether gained in college or out of it. When through his college course, he will, if his work has been properly done, be ready to begin his career in mining.

The location of this institution and its methods of instruction fit its graduates to be useful to their employers in some capacity at the start, and so far they have upon graduation experienced no difficulty in obtaining positions which give them a chance to show forth the material of which they are made. Subsequent advancement depends upon the character and the ability of the individual. His industry and the faithfulness with which he devotes himself to the interests of his employer are two most important factors.

In conclusion it may be said that only those who are willing to do hard and continuous work, both during their course at college and in the years following, should undertake to train for a career in mining. For those who are thus willing, and who have an aptitude for engineering pursuits, the outlook is promising.

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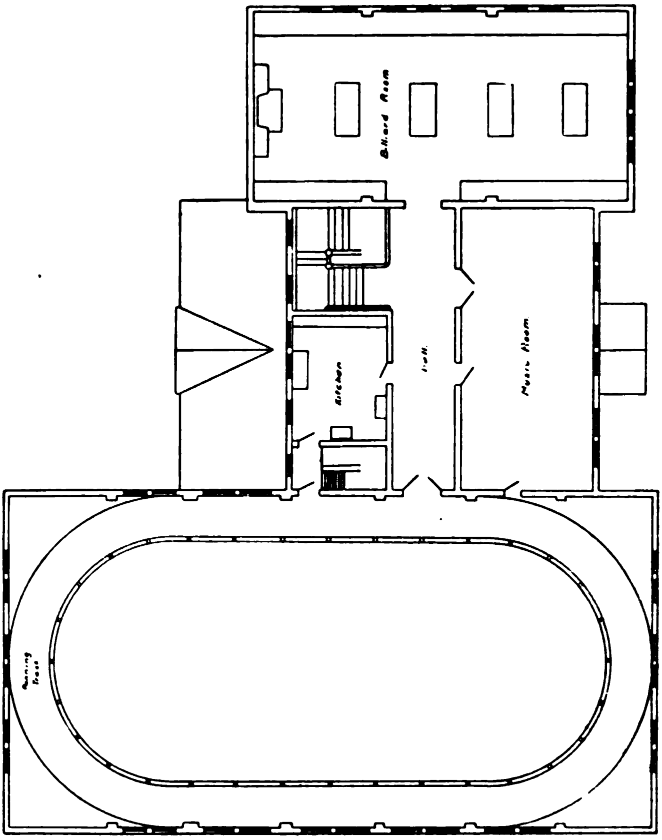

SECOND FLOOR

Besides the bound volumes on the shelves, the Library contains over 4,500 pamphlets, classified and accessible for reference, and about 1,300 maps.

There are on file 252 technical and scientific periodicals, which are issued upon application for use in the reading room which adjoins the Library.

The Library is open daily throughout the year, Sundays and legal holidays excepted. While it is intended primarily as an aid to college work, the College authorities are pleased to extend its privileges to such part of the general public as may wish to use it. Mining engineers, and those interested in scientific or technical pursuits, will find it a valuable aid in research work.

building there is a tower which carries a large steel tank at the top, thus providing a water supply for the Hydraulic Laboratory which is located in this building. There are eight floors in the tower which are used for experimental work in hydraulics, for further description of which see Course Q 3 (Hydraulics).

There are also in this building a mining engineering laboratory, a very large mapping and instrument room, a model room and mining lecture room.

The Metallurgy Building, as shown by the floor plans herewith, is a three-story building of stone and brick. It is equipped with furnaces and apparatus for laboratory work in metallurgy and in ore dressing. There is also a collection of ores, metallurgical products, refractories and fuels used for demonstrating the lectures and for study.

There is to be provided a separate furnace building, equipped with a blast-furnace for actual practice in smelting ores.

College Club House and Gymnasium.—Generous friends of the College of Mines, including the members of the Board of Control, have joined with the staff and students in providing the College with a handsome building to be used as a College Club House and Gymnasium. This building was completed in the winter of 1906. It is commodious and admirably adapted to serve its dual purpose.

The gymnasium is 45 x 90 feet in the clear and 24 feet from floor to ceiling. A running gallery is suspended 11 feet from the floor. The lighting both for day and night use is exceptionally good. The necessary locker and bath rooms with modern appliances are provided.

There are ample club rooms finished in attractive style and space is provided for the installation of bowling alleys. The building has been designed to serve also as a suitable place for such social functions as are given by the students of the institution. Altogether it will be the center of the College life outside of classroom and laboratory and will contribute very materially to the social life of the students. Those who have so generously donated to the fund for providing for this Recreation Hall are deserving of the highest praise for their substantial appreciation of the needs of the College.

The equipment is being installed as rapidly as funds are available for the purpose and it is hoped to complete it during the cur-

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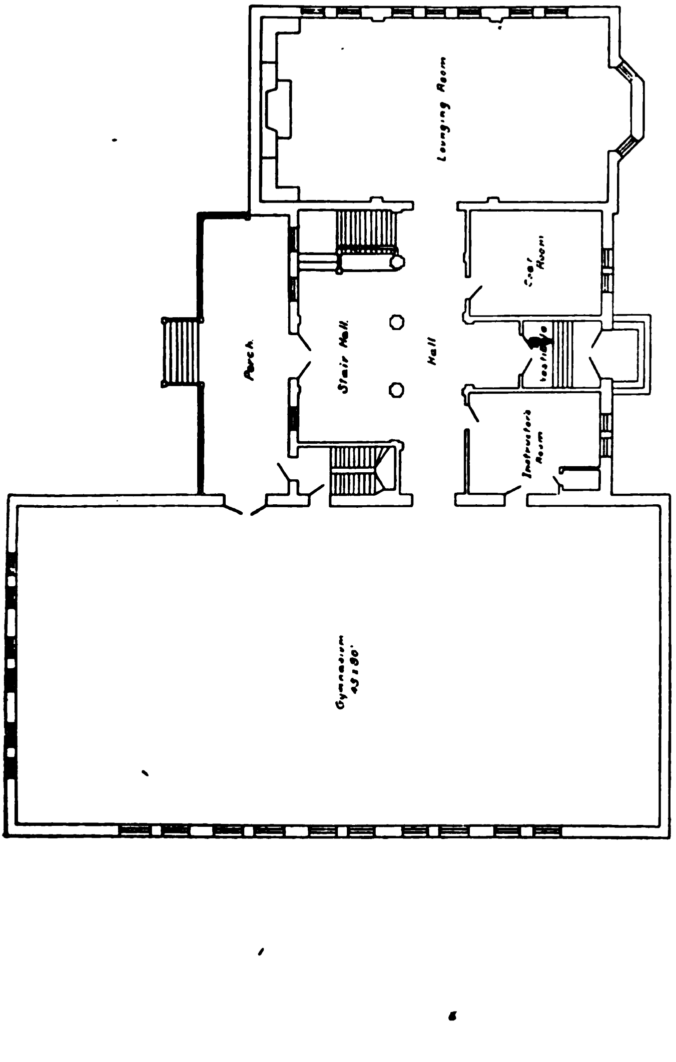

FIRST FLOOR

rent year. The building was placed in commission during the winter term of 1906 and is rapidly justifying the faith of those friends who have labored so disinterestedly to provide it.

The instructor in physical training is the director of this building and all of its activities are in his immediate charge.

The accompanying floor plan exhibits the general arrangement of this building.

TUITION, DEPOSIT AND OTHER EXPENSES

The Michigan Legislature of 1897 required the Board of Control to charge matriculation, tuition and laboratory fees. Since the people of Michigan had by taxation paid for the College buildings and equipment, it was thought by the Legislature, that those persons whose homes were outside the State, ought justly to pay higher matriculation and tuition fees than the residents of the State.

The law provides that the matriculation fee "Shall be not less than ten dollars for all persons who have been bonafide residents of this State for not less than one year immediately preceding their matriculation as students in said institution, and not less than twenty-five dollars for all others; and that tuition shall be twenty-five dollars per year to resident students, as above defined." Tuition for all others is one hundred-fifty dollars per year.

All expenses for breakage or damage to apparatus will be paid for by the student, as the laboratory fees do not cover these items.

The matriculation fee must be paid on entrance to the College. The full tuition fee for Michigan students must be paid on entrance, and applies to the unexpired portion of the year in which it is paid. Other students are required to pay the proportionate part of the tuition fee at the commencement of each term, for that term as follows: Fall, Winter and Summer terms, $40.00 each term. Spring term, $30.00.

An incidental fee of $2.50 per term on account of the College Club and Gymnasium is required of all students, and is paid at the beginning of the term to which it applies.

Laboratory fees are due when the course involving the laboratory work begins. They must be paid before the student can be admitted to the laboratory.

No partial fee can be accepted, and any fee once paid can not be refunded except in the case of protracted illness.

A student suspended, dismissed or expelled from, or voluntarily withdrawing from a class, laboratory, or the College, forfeits the fees already paid.

The scale of fees is as follows:

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[redacted]

TITLE	Resi-dent.	Non Resi-dent.
Matriculation Fee	$ 10 00	$ 25 00
Tuition Fee, annually	25 00	......
" " Fall term	......	40 00
" " Winter term	......	40 00
" " Spring term	......	30 00
" " Summer term	......	40 00
LABORATORY FEES		
B 1—Physics	3 00	3 00
B 2—Physical Measurements	2 00	2 00
B 3—Electrical Measurements	3 00	3 00
B 4—Physics	2 00	2 00
B 5—Light	1 00	1 00
F 1—Chemistry	10 00	10 00
F 2—Blowpipe Analysis	1 00	1 00
F 3—Qualitative Analysis	10 00	10 00
F 4—Volumetric Analysis	3 00	3 00
F 5—Quantitative Analysis	10 00	10 00
F 6—Synthetic Chemistry	10 00	10 00
F 7—Quantitative Analysis	7 00	7 00
G 1—Assaying	15 00	15 00
G 3—Metallurgical Laboratory Practice	10 00	10 00
G 7—Practice Work in Metallurgy	5 00	5 00
M 2—Shop Practice	10 00	10 00
M 3—Design of Structural Joints	50	50
M 6—Testing Materials	10 00	10 00
M 9—Mechanical Laboratory	10 00	10 00
M 15—Mechanical Drawing	1 00	1 00
M 16—Machine Drawing	1 00	1 00
N 3—Electrical Engineering Laboratory	5 00	5 00
Q 1—Surveying	10 00	10 00
Q 3—Hydraulics	5 00	5 00
Q 4—Topographical Drawing	1 00	1 00
Q 5—Surveying	2 00	2 00
R 3—Mine Surveying Practice	10 00	10 00
S 2—Ore Dressing	5 00	5 00
S 3—Practice Work in Ore Dressing	10 00	10 00
V 2—Palæontology	5 00	5 00
W 1—Crystallography	2 00	2 00
W 2—Mineralogy	10 00	10 00
W 3—Mineralogy	5 00	5 00
W 4—Elementary Mineralogy and Crystallography	7 00	7 00
X 1—Petrography	5 00	5 00
X 2—Advanced Petrography	5 00	5 00
Y 4—Field Geology	5 00	5 00
Gymnasium (each term)	2 50	2 [illegible]

In order partially to insure the State against damage and loss to its college property every student is required to deposit with the treasurer before entering the college, the sum of twenty-five dollars ($25). This sum cannot be withdrawn by the student until he closes his connection with the institution, and if any portion is required as a refund for damages, the part withdrawn must be at once replaced by the student.

Charges for apparatus, chemicals and other supplies from the store rooms, as well as for repairs of damages to college property, and also fines, are deducted from coupons procurable from the secretary, but no portion of the deposit of twenty-five dollars may be used for the purchase of these coupons. The coupons can be used only for the purposes mentioned, and not for the payment of any fees. The permanent deposit of twenty-five dollars, together with any balance equivalent to the unused portion of a coupon, is returned to the student when he closes his connection with the institution.

There are no dormitories connected with the College. Arrangements can be made to obtain board and room in private families, and in boarding houses, at prices varying from twenty-five dollars per calendar month upward. This is to include the room, heat and light, as well as board. Board alone can be obtained at about twenty dollars per calendar month. The College expenses vary much with the taste and habits of the student. With care the cost to a Michigan student need not exceed $450.00 per year.

[redacted]

REGULATIONS

Choice of Subjects.—Upon entering the College the student will present his choice of subjects for the year.

On or before the last Saturday of the College year, all students intending to remain during the coming year will hand to the secretary duplicate written lists of subjects chosen for that year. All candidates for a degree are required to take courses R 1 (Principles of Mining), and Y 1 (Principles of Geology). Apart from these the choice of subjects is governed by the following regulations:

In selecting the subjects for any year the student must observe the schedule both for terms and hours as given in the tables at the end of the catalogue. He must also pay attention to the proper sequence of subjects and avoid choosing subjects for which he has not covered the required preceding work. In exceptional cases a student may be allowed to take a subject out of its order, but when the work is so taken, no credit will be given for it until the required preparatory work has been made up.

After the subjects have been chosen for the year, a student can change, drop or take up any study only in the following manner: He is to hand to the secretary a written request, stating the change desired and the reasons therefor. This petition before it is given to the secretary is to bear the written approval of the heads of departments whose work is affected by the proposed change. If it is then approved by the president, the change may be made, and the secretary will give the student a notice which he is to show to the instructors interested before any change in the attendance upon classes is made. The work already done in the subject from which the change is made will not be counted, and the student must complete the required work in the subject to which he is transferred, as if the latter subject had been originally chosen.

A student who drops or takes up a course except in the manner here stated will be considered as having withdrawn from the College, and will stand suspended from all exercises in the institution.

If at any time a student is found to have work insufficient to properly occupy his time, he may be required to take additional subjects. If a student has taken up more work than he can properly perform he may be required to drop some of the subjects.

Each instructor is the sole judge of the fitness of every student electing his subjects. He may refuse to admit into his class any student found deficient in preparation, or dismiss him from his courses at any time when his conduct or work is unsatisfactory.

The student who intends to complete his work at the College in three years (see under Degrees) should take the following subjects in his first year:

A 1. Algebra.
A 2. Plane Trigonometry.
A 3. Spherical Trigonometry.
A 4. Analytic Geometry.
B 1. Physics.
F 1. General Chemistry.
F 2. Blowpipe Analysis.
M 15. Mechanical Drawing.
Q 1. Surveying
Q 4. Topographical Drawing.
R 1. Principles of Mining.
W 4. Elementary Mineralogy and Crystallography.
Y 1. Principles of Geology.

The schedule for the second year may well be as follows:

A 5. Differential and Integral Calculus.
B 4. Physics.
C 1. Analytic Mechanics.
F 3. Qualitative Analysis.
M 1. Properties of Materials.
M 2. Shop Practice.
M 5. Mechanical Engineering I.
M 11. Mechanical Engineering II.
Q 2. Hydraulics.
Q 6. Graphical Statics.
R 2. Mine Surveying and Mining.
R 3. Mine Surveying and Mining—Practical Work.
W 1. Crystallography.
W 2. Mineralogy.

In the third year there is possible a considerable latitude of choice, according to the student's purpose. For a fundamental course of broad application to the mining field the schedule for this year may be as follows:

B 5. Light.
C 2. Analytic Mechanics.
F 4. Volumetric Analysis.
F 7. Quantitative Analysis.
G 1. Assaying.
G 2. Metallurgy.
M 4. Mechanics of Materials.
M 10. Pumps and Pumping Machinery.
R 5. Mine Management and Accounts.
S 2. Ore Dressing.
S 3. Practice Work in Ore Dressing.
X 1. Petrography.
Y 3. Physical and Chemical Geology.

Absences.—All absences bring a daily mark of zero, until the work missed is made up.

A student absenting himself without excuse for more than ten per cent. of the work of any course in any term thereby dismisses himself from the College. In the case of field or laboratory courses, the limit is five per cent. instead of ten per cent.

Each tardiness counts a half absence.

Passing Grade.—A student must obtain a grade of 75 on the scale of 100 to obtain credit for any course. In case of failure to pass or complete a subject, the work can be made up only when this subject is being regularly given.

Failure.—A student failing to make a passing grade in three of the subjects in any year's work, is thereby dismissed from the College.

Laboratories.—The laboratories close Friday evening the closing day of each term, and re-open on Monday morning after the recesses.

[redacted]

PRIZES AND SCHOLARSHIPS

THE LONGYEAR PRIZES

Through the liberality of Hon. J. M. Longyear, of Marquette, the following prizes have been offered, as stated in his letter which is here appended:

MARQUETTE, MICH., Nov. 9, 1887.

Charles E. Wright, Esq., Marquette.

DEAR SIR—I wish to offer three first prizes of seventy-five dollars ($75) each, and three second prizes of fifty dollars ($50) each to be competed for by the members of the senior class of the Michigan College of Mines. The competition to be by means of papers on three subjects, written by members of the class, and submitted to the Board of Control for examination in such a manner and at such a time as the Board may determine. I desire subjects selected with a view of producing papers which will be of practical use in developing the mineral resources of the State of Michigan. I should like something which would be of service to the average woodsman or explorer, and suggest the subjects of Practical Field Geology, and the use of the Dial and Dip Compass in explorations; leaving the selection of the third subject to the judgment of the Board. If this offer is accepted and there are two or more papers on each subject submitted, I will pay seventy-five dollars to each of the writers of the three papers which may be awarded the first prizes, and fifty dollars to each of the writers of the three papers which may be awarded the second prizes.

I would suggest, however, that in case only two papers are submitted, the Board reserve the right of awarding only one prize, in case such action should seem advisable. In case only one paper should be submitted, I should like the Board to exercise its judgment in awarding a prize. It is my desire to publish the papers under the writer's name, in pamphlet form, for distribution among miners, explorers, land owners and others.

Yours very truly,

J. M. LONGYEAR.

[redacted]

In conformity with the foregoing letter, the Board of Control have decided upon the following subjects and conditions:

Subjects.

1. Field Geology; its Methods and their Applications.
2. The Dial and the Dip Compass and their Uses.
3. The Diamond Drill and its Uses.

The conditions under which the prizes are awarded are as follows:

The papers are to be presented by August 15th, for each year.

A student may present a paper upon each of the three subjects, which will entitle him to three prizes, if his papers are found worthy.

The dissertations must be prepared in the same manner as the theses, the regulations for which can be procured on application to the secretary of the College.

The title page is to have upon it an assumed name, and each paper is to be accompanied with a sealed envelope bearing the same name. This envelope must contain the writer's true, as well as assumed name, and his address. It will not be opened until the awards have been made.

No prizes will be awarded, unless the papers are judged by the committee to whom they are referred, to be of a sufficiently high standing to be entitled to a prize; hence, there may be awarded all, part, or none of the prizes, as the case may be.

These prizes can now be competed for by any student of the College, whether special, graduate or regular, without restriction to the graduating class, as was originally specified.

THE CHARLES E. WRIGHT SCHOLARSHIP.

The Charles E. Wright Scholarship was founded by Mrs. Carrie A. Wright, of Ann Arbor, in accordance with the conditions expressed in the letter which follows:

To the Honorable Board of Control of the Michigan College of Mines.

GENTLEMEN—In memory of my husband, the late Charles E. Wright, and as a token of the deep interest he had in the Michigan College of Mines, I desire to give to said College the sum of one *thousand* dollars.

[redacted]

If said gift shall be accepted, it is to be held under the following conditions:

To wit; it is to be invested as a permanent fund by the Board of Control to form the nucleus of a scholarship to be known as the Charles E. Wright Scholarship. The income is to be used for the purpose of aiding indigent students by loans under the following regulations: Loans from this income may be granted by the Board of Control upon the recommendation of the Faculty to students who have completed at least one year of study at the Michigan College of Mines, who have for the entire time of this residence a good record as to character and scholarship; who, further, intend to devote themselves to the profession of mining engineering or geology, and who are deemed deserving and needy.

Upon receipt of a loan from this Scholarship the student shall give his note for the amount of same. This note shall bear interest at the rate of five per cent. per annum from the date of his graduation or of leaving the College until paid, and shall be due on or before five years from such date.

Amounts paid on such notes shall go to increase the money to the credit of the Charles E. Wright Scholarship Fund.

(Signed) CARRIE A. WRIGHT.

THE NORRIE SCHOLARSHIP.

This scholarship was founded, and will be awarded in accordance with the conditions and requirements stated below:

Know all men by these presents, That I, A. Lanfear Norrie, of the City of New York, hereby give, grant, assign, and set over unto the Michigan College of Mines, of Houghton, Michigan, and to Peter White, D. H. Ball and J. M. Longyear, of Marquette, Michigan, as trustees, the sum of ten thousand dollars ($10,000), lawful money of the United States.

The conditions of this gift, and upon which this fund is to be taken, are that the said trustees shall invest the same upon bond and mortgage in the Village of Marquette, or in the City of Detroit, in the State of Michigan, or in the City of Milwaukee, in the State of Wisconsin, or in the City of Chicago, in the State of Illinois, upon unincumbered improved real estate.

That one-half of the income of said sum of $10,000 shall be paid

[redacted]

yearly by said trustees unto the Board of Control, for the support of some student whose father has worked in, or in some way been conneccted with mining operations in the Upper Peninsula of Michigan, who shall be designated by the Faculty of said College; and the remainder of said income shall be accumulated and invested as said principal shall be invested, and that this fund with its accumulations shall be the basis of a larger fund, to be obtained from other contributions, amounting to at least one hundred thousand dollars ($100,000), to be used for the erection of a Dormitory Building for the use of such students as shall be designated by said Faculty; which building, when erected, shall be under the exclusive control of the corporation or Board of Control of the said Michigan College of Mines.

This gift is to the said trustees and their successors forever, for the benefit of said College. In case of the death of either of said trustees, the survivors or survivor shall appoint a successor or successors.

When the erection of said building shall be commenced, after the said fund of one hundred thousand dollars is obtained, the sum hereby given, with all its accumulations, shall be paid over to the said College for the purpose aforesaid.

Witness my hand, the 30th day of January, 1890.

A. Lanfear Norrie.

Witness, T. E. O. M. Stetson.

We, Peter White, D. H. Ball and J. M. Longyear, the persons named in the above instrument, accept the trust therein granted, in all respects, and agree to comply with the conditions thereof.

Witness our hands, the 1st day of February, 1890.

Peter White,
D. H. Ball,
J. M. Longyear.

THE LONGYEAR FUND.

This is a fund of $2,500, given by the Honorable J. M. Longyear, of the Board of Control, to be the property of the College of Mines, to be used in aiding students of the College by loans in cases where the said students are unable to maintain their connnection with the College without such aid.

The conditions governing loans from this Fund are as follows: Loans may be granted by the Board of Control, upon the recommendation of the Faculty of the College to students who have completed at least one term of study at the College of Mines, who have for the entire time of residence a good record as to character and scholarship, who are deemed worthy and needy, and who shall be recommended by two responsible persons not connected with the College.

Upon receipt of a loan from this fund, the student shall give his note for the amount of same. This note shall bear interest at the rate of five per cent. per annum for the first three years from the date of his graduation or his leaving the College, and for the following two years at the rate of seven per cent. per annum. It will then be due.

This method of loaning is believed by the donor and the College to be of more benefit to the student than a gift outright, since it gives him the opportunity to pay for his own education while offering him assistance when he most needs it. It is thought that it would be better if all funds given to the College for the aid of students were accompanied with a proviso that the proceeds should go as a loan to the student rather than as a gift. Certainly the manly student hesitates to receive aid which savors of charity. It is a kindness if he can be aided in a way that will save his self-respect.

THE ALLIS-CHALMERS COMPANY SCHOLARSHIP.

The Allis-Chalmers Company of Chicago, the great manufacturers of mining and heavy machinery, offer to one member of each year's graduating class a course of four months' employment in their shops, with the addition of the sum of $150.00.

This scholarship obviously carries most excellent opportunities for practice in connection with mining machinery. It will be awarded by the Board of Control, on recommendation of the Faculty, to some graduate who has made application for it, and who has shown sufficient proficiency in mechanical lines to warrant his receiving it.

Application should be made to the Faculty as early as July 15th of the year in which the student expects his degree.

yearly by said trustees unto the Board of Control, for the support of some student whose father has worked in, or in some way been conneccted with mining operations in the Upper Peninsula of Michigan, who shall be designated by the Faculty of said College; and the remainder of said income shall be accumulated and invested as said principal shall be invested, and that this fund with its accumulations shall be the basis of a larger fund, to be obtained from other contributions, amounting to at least one hundred thousand dollars ($100,000), to be used for the erection of a Dormitory Building for the use of such students as shall be designated by said Faculty; which building, when erected, shall be under the exclusive control of the corporation or Board of Control of the said Michigan College of Mines.

This gift is to the said trustees and their successors forever, for the benefit of said College. In case of the death of either of said trustees, the survivors or survivor shall appoint a successor or successors.

When the erection of said building shall be commenced, after the said fund of one hundred thousand dollars is obtained, the sum hereby given, with all its accumulations, shall be paid over to the said College for the purpose aforesaid.

Witness my hand, the 30th day of January, 1890.

A. Lanfear Norrie.

Witness, T. E. O. M. Stetson.

We, Peter White, D. H. Ball and J. M. Longyear, the persons named in the above instrument, accept the trust therein granted, in all respects, and agree to comply with the conditions thereof.

Witness our hands, the 1st day of February, 1890.

Peter White,
D. H. Ball,
J. M. Longyear.

THE LONGYEAR FUND.

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The conditions governing loans from this Fund are as follows: Loans may be granted by the Board of Control, upon the recommendation of the Faculty of the College to students who have completed at least one term of study at the College of Mines, who have for the entire time of residence a good record as to character and scholarship, who are deemed worthy and needy, and who shall be recommended by two responsible persons not connected with the College.

Upon receipt of a loan from this fund, the student shall give his note for the amount of same. This note shall bear interest at the rate of five per cent. per annum for the first three years from the date of his graduation or his leaving the College, and for the following two years at the rate of seven per cent. per annum. It will then be due.

This method of loaning is believed by the donor and the College to be of more benefit to the student than a gift outright, since it gives him the opportunity to pay for his own education while offering him assistance when he most needs it. It is thought that it would be better if all funds given to the College for the aid of students were accompanied with a proviso that the proceeds should go as a loan to the student rather than as a gift. Certainly the manly student hesitates to receive aid which savors of charity. It is a kindness if he can be aided in a way that will save his self-respect.

THE ALLIS-CHALMERS COMPANY SCHOLARSHIP.

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This scholarship obviously carries most excellent opportunities for practice in connection with mining machinery. It will be awarded by the Board of Control, on recommendation of the Faculty, to some graduate who has made application for it, and who has shown sufficient proficiency in mechanical lines to warrant his receiving it.

Application should be made to the Faculty as early as July 15th of the year in which the student expects his degree.

MICHIGAN LOAN SCHOLARSHIPS.

By virtue of the power conferred by Act No. 81, Public Acts of 1897, the Board of Control have established twelve scholarships under the above title. These are open to Michigan students under the following regulations:

The scholarship may be granted by the Faculty of the College to students who are bona-fide residents of the State of Michigan, who have completed at least three terms of study at the College of Mines, who have during this entire time a good record as to character and work as students, and who are deemed deserving and needy.

Each scholarship is to be granted for the College year or the unexpired portion thereof, but the same student may at the option of the Faculty receive the grant more than once.

Each scholarship shall remit to the recipient the tuition and laboratory fees for the time for which he holds it, provided, however, the amount so remitted shall not exceed $75 in any one college year.

If at any time the work or conduct of the holder of one of these scholarships becomes unsatisfactory to the Faculty, he shall be deemed to have forfeited the Scholarship.

Upon receiving the grant of a scholarship the recipient shall give his note for the amount of same. The note shall bear interest at the rate of six per cent. per annum from the date of his leaving the College until paid, and shall be due on or before five (5) years from such date.

Amounts paid on such notes shall constitute a fund to be known as the Loan Scholarship Fund, which fund shall be devoted to assisting needy and worthy students by cash loans.

TEXT AND REFERENCE BOOKS

A. MATHEMATICS.

A 1. College Algebra. G. A. Wentworth. Ginn & Co., Boston.
A 2 **and** 3. Plane and Spherical Trigonometry. W. Wells. Heath & Co., Boston.
A 3. Manuscript Notes. Issued by the department.
A 4. Analytic Geometry. Tanner and Allen. American Book Co., New York.
A 5. Differential and Integral Calculus. J. M. Taylor. Ginn & Co., Boston.
A 6. A Treatise on Ordinary and Partial Differential Equations. W. W. Johnson. John Wiley & Sons, New York.

B. PHYSICS.

B 1 **and** 4. Manuscript Notes in Physics. Issued by the department.
B 1 **and** 4. Laboratory Course in Physics. Last Edition. W. C. Sabine. Ginn & Co., Boston.
B 1 **and** 4. Heat and Light. R. T. Glazebrook. The Macmillan Co., New York.
B 4. Elementary Electricity and Magnetism. D. C. and J. P. Jackson. The Macmillan Co., New York.
B 2 **and** 3. A Laboratory Manual of Physics and Applied Electricity. E. L. Nichols. The Macmillan Co., New York.
B 2. Lessons on Elementary Practical Physics. Vols. I and II. Balfour Stewart and W. W. Haldane Gee. The Macmillan Co., New York.
B 3. Electrical Measurements. H. S. Carhart and G. W. Patterson, Jr. Allyn & Bacon, Boston.

[redacted]

C. MECHANICS.

C **1 and 2.** Mechanics of Engineering. I. P. Church. John Wiley & Sons, New York.

F. CHEMISTRY.

F 1. Chemistry Simplified. George A. Koenig. H. Carey Baird & Co., Philadelphia.

F 1. Inorganic Chemistry. Richter, Smith. P. Blakiston, Son & Co., Philadelphia.

F 1. Treatise on Chemistry. Roscoe and Schorlemmer. D. Appleton & Co., New York.

F 2. Manual of Determinative Mineralogy. Edition 13. George J. Brush. John Wiley & Sons, New York.

F 2. Landauer's Blowpipe Analysis. 1892. Translated by James Taylor. The Macmillan Co., New York.

F 3. Notes on the Chemistry of Metals and the Analytical Relations of the Metallic Compounds. G. A. Koenig.

F 4. Electrolytic Methods. E. F. Smith. J. B. Lippincott Co., Philadelphia.

F 6. Theoretical Chemistry. Ira Remsen. Lea Bros. & Co., Philadelphia.

F 6. Elements of Physical Chemistry. H. C. Jones. The Macmillan Co., New York.

F 6. Introduction to Physical Chemistry. J. Walker. The Macmillan Co., New York.

F 7. A System of Instruction in Quantitative Chemical Analysis. C. R. Fresenius. Edition 10. Edited by O. D. Allen and S. W. Johnson. John Wiley & Sons, New York.

G. METALLURGY.

G 1. Manuscript Notes on Assaying. 1895. George A. Koenig.

G 1. Introduction to the Study of Metallurgy. Roberts-Austen. J. B. Lippincott Co., Philadelphia.

G 1. Manual of Assaying. A. S. Miller. Engineering and Mining Journal Co., New York.

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G 1. Metallurgy of the Well-Known Metals. L. S. Austin. Mining and Scientific Press Ptg. Co., San Francisco.

G 2. Metallurgy of Lead. Last Edition. H. O. Hofman. Scientific Publishing Co., New York.

G 2. Modern American Methods of Copper Smelting. Last Edition. E. D. Peters. Scientific Publishing Co., New York.

G 2. Fuel and Refractory Materials. A. H. Sexton. Blackie & Sons, London.

G 2. Metallurgy of Zinc. W. R. Ingalls. Engineering and Mining Journal Co., New York.

G 2. Cyanide Practice. A. James. Engineering and Mining Journal Co., New York.

G 2. Metallurgy of Gold. T. K. Rose. J. B. Lippincott & Co., Philadelphia.

G 2. Metallurgy of Silver. H. F. Collins. J. B. Lippincott & Co., Philadelphia.

G 2. Handbook of Metallurgy. C. Schnabel. Translated by H. Louis, 1905. The Macmillan Co., New York.

G 2. The Cyanide Process. J. Park. J. B. Lippincott & Co., Philadelphia.

G 3. Metallurgical Laboratory Notes. H. M. Howe. Engineering and Mining Journal Co., New York.

G 5. Corporate Management. Conyngton. The Roland Press, New York.

S 3. Ore Dressing. R. H. Richards. Ed. of 1903. (2 Vols.) Engineering and Mining Journal Co., New York.

S 3. Machinery of Metalliferous Mines. Davies. D. Van Nostrand Co., New York.

S. ORE DRESSING.

S 2. Ore Dressing. R. H. Richards. Edition of 1903. Engineering and Mining Journal Co., New York.

S 3. Ore Dressing. R. H. Richards. Edition of 1903. (2 Vols.) Engineering and Mining Journal Co., New York.

M. MECHANICAL ENGINEERING.

M 1 and 6. The Materials of Construction. J. B. Johnson. John Wiley & Sons, New York.

[redacted]

M 2. Pattern Maker's Assistant. Joshua Rose. D. Van Nostrand Co., New York.

M 2. Modern Machine Shop Tools. Vandervoort. N. W. Henley & Co., New York.

M 4. Text-Book on the Mechanics of Materials. Mansfield Merriman. John Wiley & Sons, New York.

M 4. "Cambria Steel."

M 5. The Mechanical Engineering of Power Plants. F. R. Hutton. John Wiley & Sons, New York.

M 6. Hydraulic Cement. F. P. Spaulding. John Wiley & Sons, New York.

M 9. Experimental Engineering. R. C. Carpenter. John Wiley & Sons, New York.

M 10. Pumping Machinery. W. M. Barr. J. B. Lippincott Co., Philadelphia.

M 12. The Steam Engine Vol. I, by Heck. D. Van Nostrand & Co., New York.

M 13. Mechanical Engineer's Pocket Book. W. Kent. J. Wiley & Sons, New York.

M 14. Compressed Air and its Application. Hiscox. N. W. Henley & Co., New York.

M 15. Lettering for Draughtsmen. C. W. Reinhardt. D. Van Nostrand, New York.

M 15. Elements of Mechanical Drawing. Last Edition. G. C. Anthony. D. C. Heath & Co., Boston.

M 16. Machine Drawing. Last Edition. G. C. Anthony. D. C. Heath & Co., Boston.

N. ELECTRICAL ENGINEERING.

N 1. Incandescent Wiring Hand Book. T. B. Badt. Electrical Publishing Co., Chicago.

N 1. Electrical Engineering. Rosenberg, Gee & Kinzbrunner. J. Wiley Sons, New York.

Q. CIVIL ENGINEERING.

Q 1, 4 and 5. Theory and Practice of Surveying. Last Edition. J. B. Johnson. John Wiley & Sons, New York.

Q 1. Field Engineering. Last Edition. William H. Searle. John Wiley & Sons, New York.

Q 2 and 3. A Treatise on Hydraulics. Last Edition. Mansfield Merriman. John Wiley & Sons, New York.

Q 4 and 5. The Theory and Practice of Lettering. C. E. Sherman, Columbus, Ohio.

Q 4. A practical System of Freehand Lettering. Charles W. Reinhardt. D. Van Nostrand Co., New York.

Q 6. Graphic Analysis of Roof Trusses. Last Edition. Charles E. Green. John Wiley & Sons, New York.

R. MINING ENGINEERING.

R 1. Elementary Mining and Quarrying. Last Edition. C. LeNeve Foster. J. B. Lippincott Co., Philadelphia.

R 2. Manuscript Notes on Mine Surveying and Mining. Revised, 1901. F. W. Sperr.

R 4. Manuscript Notes on Mine Engineering. Revised, 1903. F. W. Sperr.

R 5. Manuscript Notes on Mine Management and Accounts. Revised, 1905. F. W. Sperr.

V. BIOLOGY.

V 2. Comparative Zoology. 1895. James Orton. Harper & Bros., New York.

V 2. A Text-Book of Palaeontology. 1900. Karl Von Zittel. Translated by Charles R. Eastman. The Macmillan Co., New York.

W. MINERALOGY.

W 1. Elements of Crystallography. Last Edition. G. H. Williams. H. Holt & Co., New York.

W 2. A Text Book of Mineralogy. Sixth Edition. 1903. James D. Dana and E. S. Dana. John Wiley & Sons, New York.

W 3. A System of Mineralogy. 1905. E. S. Dana. John Wiley & Sons, New York.

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X. PETROGRAPHY.

X 1. Microscopical Physiography of the Rock Making Minerals. Third Edition, 1893. H. Rosenbusch. Translated by J. P. Iddings. John Wiley & Sons, New York.

Y. GEOLOGY.

Y 1. Elements of Geology. Norton. Ginn & Co., New York.

Y 2. Geology. Vols. 2 and 3. Chamberlain and Salisbury. H. Holt & Co., New York.

Y 3. Geology. Vol. 1. Chamberlain and Salisbury. H. Holt & Co., New York.

Y 5. Economic Geology of the United States. H. Ries. The Macmillan Co., New York. Or Ore Deposits of the United States. J. F. Kemp. John Wiley & Sons, New York.

STUDENTS ENROLLED IN 1904-1905

Whose names do not appear in the register of students published for that year.

Bartlett, Hiram Lawrence,	*Harbor Beach.*
Hodge, Walter Roberts,	*Houghton.*
Kratz, Arthur Murray,	*Calumet.*

[redacted]

REGISTER OF STUDENTS, 1905-1906

NAME.	RESIDENCE.
Alsip, Albert Arthur,	*Chicago, Ill.*
Ambrose, Charles Wilkins,	*Bay City.*
Anderson, George Andrew,	*Detroit.*
Anderson, Merton Baird,	*Calumet.*
Anderson, Vern,	*Ionia.*
Andrews, Worth Briggs,	*Duluth, Minn.*
Austin, Arthur, M.E. (Colorado State School of Mines),	*Houghton.*
Austin, Charles Luther,	*Saginaw.*
Bailey, Alfred Colin,	*Sault Ste. Marie.*
Baker, Albert Means,	*Yellow Springs, O.*
Balard, John Irwin,	*Alliance, O.*
Barabe, Clifford Aloysius,	*Houghton.*
Barclay, Robert Hargrove, B.E.M. (Kentucky State College, Louisville, Ky.),	*Louisville, Ky.*
Barr, James Allen,	*Escanaba.*
Bennett, Thomas Herbert,	*Houghton.*
Beyer, William F.,	*Houghton.*
Bolley, William Remington,	*Eagle River.*
Buchanan, Jerome Robinson,	*Pasadena, Cal.*
Buchman, Louis	*Rapid River.*
Burhans, Harry Hatch,	*Superior, Wis.*
Burke, Gilbert Michael,	*Canandaigua, N. Y.*
Byrne, Harry William,	*Bessemer.*
Campbell, David Henry, Ph.G. (Massachusetts College of Pharmacy),	*Denver, Colo.*
Campbell, Frank Alvord,	*Kalamazoo.*
Carleton, Edward Jones,	*Minneapolis, Minn.*
Carrigan, James J.,	*Hancock.*
Cavan, David Brigham,	*Houghton.*
Chadbourne, Humphrey Wallingford,	*Houghton.*
Champoux, Adolph,	*Houghton.*
Cook, Thomas Clair,	*Toledo, O.*
Corey, George Watson, B.S. (Michigan College of Mines),	*Houghton.*
Crowdus, John William, B.S. (Michigan College of Mines),	*Dallas, Tex.*
Dallas, James R.,	*Pittsburg, Pa.*
d'Autremont, Louis Paul,	*Duluth, Minn.*

NAME.	RESIDENCE.
Dawson, Richard Trafton,	*Owosso.*
Dent, Charles Ralph,	*Warrior's Mark, Pa.*
Derwin, Lewis Thomas,	*Otisville.*
DeWilde, Felix Julius,	*Sheboygan, Wis.*
Dickinson, Albert Wright,	*Chicago, Ill.*
Dillon, Harry Thomas,	*Houghton.*
Dobbins, William John,	*Ionia.*
Dobbs, Gerald George,	*Kingston, Ontario, Can.*
Doll, Myron George,	*Ann Arbor.*
Douglass, Robert Humphrey,	*Houghton.*
Downing, Robert Lee,	*St. Paul, Minn.*
Drake, John Miller, Jr.,	*San Jose, Cal.*
Duncan, Lawrence Grant, B.S. (Michigan College of Mines),	*St. Joseph, Mo.*
Earling, Roy Brown,	*Milwaukee, Wis.*
Edyvean, Edmund H.,	*Lake Linden.*
Fitch, Cecil A.,	*Beacon.*
Fitch, Richard Smithson,	*Warrensburg, Pa.*
Fitch, Walter Aubrey,	*Beacon.*
Fox, Arthur Cristof,	*Houghton.*
Freeman, Lawrence Kimball,	*Lansing.*
Friedman, Myron,	*Chicago, Ill.*
Furbeck, John Philip,	*Oak Park, Ill.*
Gage, Walter Henry,	*Saginaw.*
Gaul, John C.,	*Calumet.*
Gerry, Alex. LeRoy,	*Danbury, Conn.*
Getchell, Walter Charles,	*Mount Pleasant.*
Gibbs, Chester Alma,	*Houghton.*
Gibbs, Harry,	*Houghton.*
Gilbert, Isaac Leggett,	*Detroit.*
Glass, Frank A.,	*Wilkinsburg, Pa.*
Goodman, George William,	*Sands.*
Grace, Harry Holder, Jr.,	*Superior, Wis.*
Graham, Ernest R.,	*Croswell.*
Grant, Wilbur Henry,	*Ann Arbor.*
Haggerty, Howard,	*Detroit.*
Hallingby, Ole,	*Calumet.*
Halter, Richard Grant,	*Chihuahua, Mex.*
Hamilton, Orr Ross,	*Denver, Colo.*
Hartness, James Cameron,	*Houghton.*
Hasselbring, Albrecht,	*Flint.*
Hawkins, Lewis Wood,	*Benton Harbor.*
Hedenstrom, Louis Henry,	*St. Paul, Minn.*
Heine, Harry William,	*St. Paul, Minn.*
Henderson, Enoch, B.S. (Michigan College of Mines),	*Norway.*
Hellberg, Edward Adolf,	*Norway.*
Hennes, Frank,	Houghton.

NAME.	RESIDENCE.
Hermann, Charles Frederick,	*Calumet.*
Hicks, Bert Reed,	*Oshkosh, Wis.*
Hines, Pierre Rossiter,	*El Paso, Tex.*
Hitchcock, Clarence Horace,	*Ludington.*
Hodge, Walter Roberts,	*Houghton.*
Holden, Edgar Freeborn,	*Muskegon.*
Holman, William Chester,	*Calumet.*
Hood, Ben Benight,	*Houghton.*
Hotchkin, Merritt Windes,	*Chicago, Ill.*
Hough, William James,	*Toledo, O.*
Houston, Fred Kennedy,	*Beaver, Pa.*
Huston, Milton Benjamin,	*Ypsilanti.*
Jackman, Herbert Everard, Ph.B. (Syracuse University),	*East Jordan.*
Jacobson, Jacob Wilho,	*Hancock.*
Jefferson, Harry Edward Curzon,	*Houghton.*
Johnson, Herbert Willis,	*Ishpeming.*
Jones, Edward Raymond,	*North Henderson, Ill.*
Kelley, Frank Arthur,	*Minneapolis, Minn.*
Kelly, Charles Brace,	*Grand Rapids.*
Kelsey, Newton Standish,	*San Francisco, Cal.*
Kimball, Eugene Delroy,	*Minneapolis, Minn.*
King, Carl Benton,	*Hancock.*
Kingston, Carl John,	*Central Mine.*
Kirkpatrick, Marsena Richard,	*Bellingham, Wash.*
Klinglund, Frank David,	*Sault Ste. Marie.*
Koontz, Kinter Kenneth,	*Johnstown, Pa.*
Kruse, Henry Joseph,	*Beacon.*
Kumke, Charles,	*Detroit.*
Kuntz, Julius Matthew,	*Houghton.*
Land, Charles Henry,	*Detroit.*
Langley, Clifton Evans,	*Detroit.*
Langworthy, William Probasco,	*Houghton.*
Lavery, Vaughan Metcalfe,	*Evanston, Ill.*
Leland, Everard,	*Fennville.*
Lewis, William Frank,	*Kenton.*
Lidberg, Oscar Julian,	*Ishpeming.*
Lindberg, Carl Otto,	*Houghton.*
McClintock, Hallett Edward,	*Iron Mountain.*
McCollom, Charles Rolfe,	*Minneapolis, Minn.*
McFadden, Joel Parkhurst,	*Chicago, Ill.*
McGrath, Thomas James,	*La Fayette, Ind.*
McIntyre, Robert,	*Helena, Mont.*
MacKenzie, Alexander Melville,	*Calumet.*
MacKillican, James Angus,	*Escanaba.*
Mace, Henry Arthur,	*Duluth, Minn.*
Mailhot, Charles Moise,	*Houghton.*
Maitland, Harvey Keith,	*Negaunee.*

NAME.	RESIDENCE.
Mandis, Charles Urban,	*Calumet.*
Manly, Aden J.,	*Deerfield.*
Mark, Perry Charles,	*Zanesville, O.*
Marshall, George Bowen,	*New York City.*
May, Karl Axtell,	*Cambridge, Wis.*
Meek, Harry Calvin,	*Manton.*
Mesick, Richard Smith,	*Petoskey.*
Mitchell, James MacDonald,	*Flushing, N. Y.*
Montagu, Austin Robert,	*Cromore, N. Ireland.*
Morgan, Howard Wall,	*Milwaukee, Wis.*
Muir, Neal Matthew,	*St. Paul, Minn.*
Netzorg, Leon Zelazny,	*Detroit.*
Newton, Charles Edward,	*Denver, Colo.*
Nolan, Joseph P,	*Ishpeming.*
Olk, Henry John	*Antigo, Wis.*
Ortiz, Vicente Nicolas,	*Mexico City, Mex.*
Pattison, William Brooks,	*Kalamazoo.*
Peacock, Ceth,	*New Buffalo.*
Pearce, Edward J.,	*Negaunee.*
Pearce, Lewis Frederick,	*Negaunee.*
Penberthy, Ira Gladstone,	*Calumet.*
Perkins, William James,	*Norway.*
Perry, Joseph Bond,	*Joliet, Ill.*
Pickard, Byron Oscar,	*Omaha, Neb.*
Pohle, Louis Henry,	*Seattle, Wash.*
Pollock, Frank Albert,	*Duluth, Minn.*
Pratt, John Brooks,	*Milwaukee, Wis.*
Presho, Edward Webb, B.A. (Tufts College),	*Los Angeles, Cal.*
Pullen, Lester Lloyd,	*Buffalo.*
Quinn, Clement Kruse,	*Beacon.*
Randolph, George Oscar,	*Marquette.*
Rathman, Fred John,	*Grand Rapids.*
Redmond, William,	*Ishpeming.*
Reed, Thomas Hitchcock,	*Kansas City, Mo.*
Reeder, John Harry,	*Calumet.*
Reynolds, Frank Arthur,	*Detroit.*
Ricks, Glen Armour,	*Taylorville, Ill.*
Roe, Ira Smith,	*Detroit.*
Rose, Arthur Herbert,	*Evart.*
Rough, Albert James,	*Marquette.*
Royce, Frederic,	*Hancock.*
Rumsey, Edward Prole,	*Batavia, N. Y.*
Ruthrauff, Arthur G.,	*Otsego.*
Sanford, William Craig, Jr.,	*Pontiac.*
Scallon, Edward Philip,	*Hancock.*
Schacht, William Henry,	*Ishpeming.*
Schaus, Oliver Montell,	Milwaukee, Wis.

[redacted]

SUMMARY OF STUDENTS, 1905-1906

BY STATES AND COUNTRIES.

Arizona	1
California	4
Canada	3
Colorado	3
Connecticut	1
Illinois	13
Indiana	1
Ireland	1
Kentucky	1
Massachusetts	1
Mexico	3
Michigan { Upper, 83; Lower, 55 }	138
Minnesota	14
Missouri	2
Montana	1
Nebraska	1
New York	5
Ohio	6
Oregon	1
Pennsylvania	8
Texas	2
Washington	2
Wisconsin	13
Total	225
Average Age of Students, 1905-06	22½ years

SUMMARY OF ENROLLMENT DURING EXISTENCE OF THE COLLEGE

The number of new students who entered, the total enrollment, and the number of graduates sent out for each year of the existence of the College, are as follows:

Year	86–7	87–8	88–9	89–90	90–1	91–2	92–3	93–4	94–5	95–6	96–7	97–8	98–9	99–00	1900–01	1901–02	1902–03	1903–04	1904–05	1905–06
New students	23	15	16	15	46	40	45	17	49	43	82	33	42	54	71	95	92	101	99	94
Total attendance	23	29	40	35	61	78	101	82	94	94	140	122	116	121	146	197	221	238	223	225
Graduates	..	7	6	5	4	..	8	17	22	18	5	18	24	19	25	24	42	41	43	..

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EXPLANATION OF TABLES AND MAPS

TABLES.

Table I shows the term or terms in which each subject is taught, its proportionate credit in tenths of a unit, the number of times each week that the student must appear in class-room for recitation or lecture, and the total number of hours each week an average student is expected to put upon the subject. This total includes both laboratory and study time with the class-room time. The time spent at the College includes both the recitation and laboratory hours.

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To make clear the fact of the location of the College of Mines in the midst of active mining operations, two maps are shown.

The first gives a detailed exhibit of the Portage Lake Mining District, which forms the immediate vicinity of the College. Most of the active copper mines within the territory covered by this map are indicated on it.

The second is a general map of the mineral districts of the Upper Peninsula. It shows the various iron and copper ranges which are accessible from the College. No attempt has been made to indicate the different mining districts of the Copper Range, nor the subdivisions of the Iron Ranges.

different mining districts of the Copper Range, not
of the Iron Ranges.

n, 1906

FRIDAY.	SATURDAY.
2. Plane Trigonometry, Sec's [1 and 2. [illegible] Calculus, Sec's 1 and 2. 2. Metallurgy, Sec. 1.	A 1. Algebra, Sec's 1 and 2. F 4. Volumetric Analysis, Sec. 2. M 4. Mechanics of Materials, [Sec. 1.
2. Plane Trigonometry, Sec. 3. 5. Calculus, Sec. 3. 0. Pumps and Pumping [Machinery.	A 1. Algebra, Sec. 3. F 3. Qualitative Analysis, Sec. 2. G 5. Metallurgical Organization. M 4. Mechanics of Materials, [Sec. 2.
5. Calculus, Sec. 4. 2. Analytic Mechanics, Sec. 1. 4. Elementary Mineralogy.	F 1. General Chemistry, Sec. 1. M 1. Properties of Materials, [Sec. 3. M 5. Mechanical Engineering, I. [Sec. 1.
2. Plane Trigonometry, Sec's 4 [and 5. 2. Analytic Mechanics, Sec. 2. 5. Mechanical Drawing, Sec. 1. 2. Palæontology.	A 1. Algebra, Sec's 4 and 5. F 3. Qualitative Analysis, Sec. 1. M 4. Mechanics of Materials, [Sec. 3. Y 5. Economic Geology.
4. Physics. 2. Mechanical Engineering, III. 5. Mechanical Drawing, Sec. 2.	M 1. Properties of Materials, [Sec. 1. X 1. Petrography.
1. General Chemistry, Sec's 1, [2, 3 and 4. 2. Metallurgy, Sec. 2. 5. Mechanical Engineering I. [Sec. 2.	G 4. Metallurgical Designing. M 1. Properties of Materials. [Sec. 2.
5. Mechanical Drawing, Sec. 3. 6. Graphical Statics, Sec's 1, 2 [and 3.	M 5. Mechanical Engineering, I. [Sec. 3. N 1. Electrical Engineering.
4. Volumetric Analysis, Sec. 1. 1. Crystallography.	

different mining districts of the Copper Range, not
of the Iron Ranges.

rm, 1906

FRIDAY.	SATURDAY.
2. Plane Trigonometry, Sec's [1 and 2. 5. Calculus, Sec's 1 and 2. 2. Metallurgy, Sec. 1.	A 1. Algebra, Sec's 1 and 2. F 4. Volumetric Analysis, Sec. 2. M 4. Mechanics of Materials, [Sec. 1.
2. Plane Trigonometry, Sec. 3. 5. Calculus, Sec. 3. 10. Pumps and Pumping [Machinery.	A 1. Algebra, Sec. 3. F 3. Qualitative Analysis, Sec. 2. G 5. Metallurgical Organization. M 4. Mechanics of Materials, [Sec. 2.
5. Calculus, Sec. 4. 2. Analytic Mechanics, Sec. 1. 4. Elementary Mineralogy.	F 1. General Chemistry, Sec. 1. M 1. Properties of Materials, [Sec. 3. M 5. Mechanical Engineering, I, [Sec. 1.
2. Plane Trigonometry, Sec's 4 [and 5. C 2. Analytic Mechanics, Sec. 2. M 15. Mechanical Drawing, Sec. 1. 2. Palæontology.	A 1. Algebra, Sec's 4 and 5. F 3. Qualitative Analysis, Sec. 1. M 4. Mechanics of Materials, [Sec. 3. Y 5. Economic Geology.
B 4. Physics. M 12. Mechanical Engineering, III. M 15. Mechanical Drawing, Sec. 2.	M 1. Properties of Materials, [Sec. 1. X 1. Petrography.
F 1. General Chemistry, Sec's 1, [2, 3 and 4. G 2. Metallurgy, Sec. 2. M 5. Mechanical Engineering I, [Sec. 2.	G 4. Metallurgical Designing. M 1. Properties of Materials, [Sec. 2.
M 15. Mechanical Drawing, Sec. 3. N 6. Graphical Statics, Sec's 1, 2 [and 3.	M 5. Mechanical Engineering, I, [Sec. 3. N 1. Electrical Engineering.
F 4. Volumetric Analysis, Sec. 1. W 1. Crystallography.	

Time Schedule: Fa

erm, 1907

FRIDAY.	SATURDAY.
A 4. Analytic Geometry, Sec's 1 and 2. A 5. Calculus, Sec. 1. C 1. Analytic Mechanics, Sec. 1. R 4. Mining Engineering.	A 5. Calculus, Sec. 1. G 3. Metallurgical Laboratory Practice. M 4. Mechanics of Materials, Sec. 1. N 1. Electrical Engineering.
A 5. Calculus, Sec's 2 and 3. C 1. Analytic Mechanics, Sec. 2. F 7. Quantitative Analysis, Sec. 1.	A 1. Algebra, Sec. 1. A 5. Calculus, Sec's 2 and 3. G 6. Metallurgical Accounts. M 4. Mechanics of Materials, Sec. 2.
C 1. Analytic Mechanics, Sec's 3 and 4. M 16. Machine Drawing, Sec. 1. R 5. Mine Management and Accounts. Y 1. Principles of Geology.	A 1. Algebra, Sec's 2 and 3. A 5. Calculus, Sec. 4. M 3. Design of Structural Joints.
A 4. Analytic Geometry, Sec's 3, 4 and 5. A 5. Calculus, Sec. 4. Y 2. Historical Geology.	A 1. Algebra, Sec's 4 and 5. F 3. Qualitative Analysis, Sec. 1. M 4. Mechanics of Materials, Sec. 3. Y 5. Economic Geology.
B 1. Physics. M 16. Machine Drawing, Sec. 2. Q 7. Engineering Design and Construction.	M 1. Properties of Materials, Sec. 1. X 1. Petrography.
F 7. Quantitative Analysis, Sec. 2. G 2. Metallurgy, Sec. 1. W 2. Mineralogy.	M 1. Properties of Materials, Sec. 2.
F 1. General Chemistry, Sec's 1, 2, 3 and 4. R 2. Mine Surveying and Mining.	B 3. Electrical Measurements. Q 2. Hydraulics, Sec's 1, 2 and 3.
F 3. Qualitative Analysis, Sec. 3. G 2. Metallurgy, Sec. 2. R 1. Principles of Mining, Sec. 4.	
F 3. Qualitative Analysis, Sec. 2. M 16. Machine Drawing, Sec. 3. M 1. Properties of Materials, Sec. 3.	

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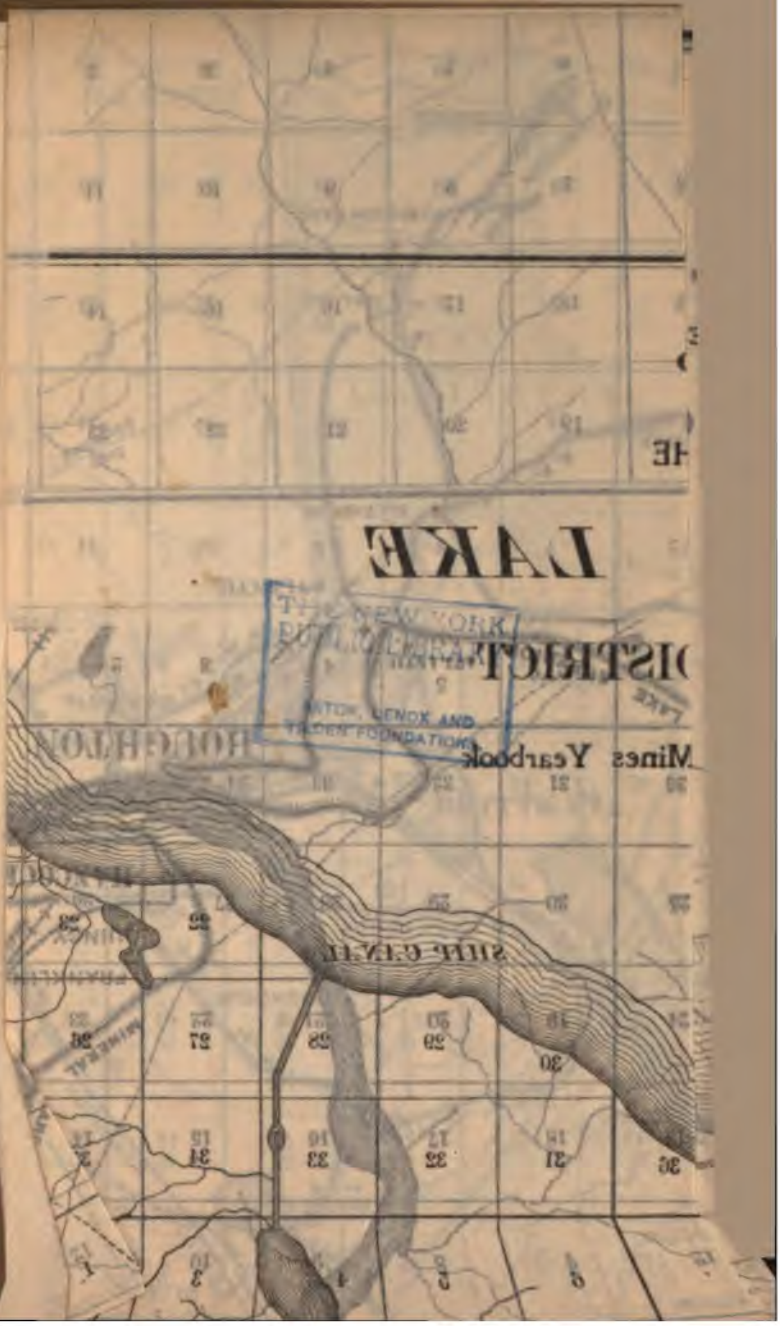

YEAR BO

OF THE

Michigan College

1906-1907

ANNOUNCEMENT OF COURSES FOR 1

HOUGHTON, MICHIGAN

PUBLISHED BY THE COLLEGE
MAY, 1907

YEAR BOOK

OF THE

ichigan College of

1906-1907

ANNOUNCEMENT OF COURSES FOR 19

HOUGHTON, MICHIGAN

PUBLISHED BY THE COLLEGE
MAY, 1907

C. M. H.

PRINTERS

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BOARD OF CONTROL OF THE MICHIGAN COLLEGE OF MINES

	Term Expires
Hon. John Monroe Longyear, Marquette, - - -	June 9, 1907
Norman Washington Haire, Houghton, - - -	June 9, 1907
William Kelly, Vulcan - - - - - - - - -	June 9, 1909
James MacNaughton, Calumet, - - - - -	June 9, 1909
Murray Morris Duncan, Ishpeming, - - - -	June 9, 1911
Lucius Lee Hubbard, Houghton, - - - - -	June 9, 1911

Chairman of the Board of Control, - - - - William Kelly

Secretary of the Board of Control, - - - Fred Walter McNair

1907

JANUARY

S	M	T	W	T	F	S
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1908

JANUARY

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20	21	22	23	24	25	26
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Calendar, 1907-1908

FALL TERM begins Friday morning, September 27, 1907, and ends Friday noon, December 20, 1907—twelve weeks.

Examinations for admission and advanced standing begin Friday morning at 9 o'clock and continue through Friday and Saturday.

Regular work for all classes begins Monday, September 30, 1907, at 8 a. m. Full work is to be taken up at this time.

Thanksgiving Recess from Wednesday noon, November 27, until Monday morning, December 2, 1907.

WINTER TERM begins Monday morning, January 6, and ends Friday noon, March 20, 1908—eleven weeks.

SPRING TERM begins Monday morning, March 30, and ends Saturday evening, June 6, 1908—ten weeks.

SUMMER TERM begins Monday morning, June 8, 1908, and ends Friday evening, August 28, 1908—twelve weeks.

Practical work in Mine Surveying and Mining begins Monday morning, May 4, and ends Friday evening, June 5, 1908.

Surveying begins Monday morning, June 8, and ends Thursday evening, August 27, 1908.

Shop Practice begins Monday morning, June 8, and ends Thursday evening, August 27, 1908.

Mechanical Laboratory Practice begins Monday morning, June 8, and ends Friday evening, July 17, 1908.

Practice work in Metallurgy begins Monday morning, June 8, and ends Friday evening, June 26, 1908.

Practice work in Ore Dressing begins Monday morning, June 29, and ends Friday evening, July 17, 1908.

Field Geology, Electrical Engineering Laboratory and Testing Materials of Engineering begin Monday morning, July 20, and end Thursday evening, August 27, 1908.

[redacted]

A record of Graduates up to and including the class of 1905, giving their occupations, is published separately and will be sent upon request. A record of the class of 1906 is given in this year book.

OTHER EMPLOYEES

HENRY GIBBS,
Purchasing Agent and Supply Clerk.

HARRY SHARP,
President's Secretary and Accountant.

DONALD FRAMPTON,
Stenographer.

VINCENT UREN,
Engineer.

MAXIME MORIN,
Carpenter.

FREDERICK CHARLES STRASSER,
Chief Janitor.

The College was established for, and exists only for the purpose of training men to take an active part in the development of the mineral wealth of the state and nation. This concentration of effort on a particular line of training has its advantages. Many of the perplexing problems which arise where numerous lines of effort must be simultaneously proceeding are unknown in this institution. Here all work for a common object. Every employee has his share in whatever of success the College attains. This condition develops a spirit of harmonious endeavor which facilitates greatly the work of instruction.

The College has been particularly fortunate in the matter of its location. It is plain that an engineering school must derive immense advantage from a location in which its immediate surroundings continually illustrate and enforce the principles which it teaches. When the line of operation for which it is training its students is the dominant one of the region, obviously the advantage is greatest. Then the environment, even without effort on the part of the school, must serve as an efficient aid to the instruction. If those in control of these operations are in sympathy with the institution—are ready to place plants under their charge at its service for instruction, and if the institution makes wise use of opportunities thus afforded, these plants become truly a part of its equipment, and the environment then becomes a factor which must increase the efficiency of the instruction by an amount hardly to be overestimated.

The location of the Michigan College of Mines presents in a marked degree all these features. It is situated in the heart of the great copper mining region of Lake Superior.* Within a radius of eleven miles from its site are some fifteen active copper mines. Several of the largest, most extensively equipped, and most successful metal mines in the world are among them. The deepest shafts in the world and the most powerful machinery employed in mining are here in constant operation.

Besides the plants at the mines there are necessary docks, railroads, mills and smelters. To all the student has access, and he is required, under the direction and supervision of his instructors, to visit and inspect these plants and their operation at proper times during his study here. By being in such a district and being required to use its opportunities as he is, the student breathes from his arrival

*See map at end of year-book.

an atmosphere in entire harmony with his present and future work. He is continually inspired by observation of and contact with men who have achieved success in the line for which he is training. This location, together with the practical methods of training employed, account for the remarkable fact that of 378 men graduated up to this time, but seven have left engineering for other pursuits.

The methods of instruction include the ordinary lecture, text-book and recitation work, supplemented in every department by problems drawn as far as possible from actual practice. Because the successful engineer must be a man whose judgment of *things* is well developed, laboratory methods of instruction are given great prominence. These include the trips and the laboratory courses in which the student works with his own hands rather than watches the operations of some one else. The trips of inspection are to plants which exemplify often on a large scale the application of principles taught in the classroom to problems of commercial operation. The study of such application serves to vivify the teaching and brings to the student a clearer comprehension and firmer grasp of the subject in hand. But it is obvious that in the attempt to apply the principle to some concrete problem of practice, the student will most speedily gain a true comprehension of its bearing and force. He should therefore have as far as possible his practice in the field or in properly directed laboratories. This the College endeavors to give.

Necessarily the nearer the field or laboratory practice is made to conform to the requirements of actual operation, the more forcible its teachings and the more valuable the experience here gained. This point is attended to in the various practice courses given at this institution. Moreover in such practice properly directed, lies the chief resource of the College in its effort to stimulate and influence the development of judgment on the part of the student. Under the proper sub-heads in the section of the year-book devoted to "Departments of Instruction," and in the section headed "Buildings," will be found a more detailed description of the means possessed by the College for instruction in field and laboratory, as well as a more particular account of the manner of using the several parts of the equipment and the various features of the surroundings for the purpose of giving engineering training.

The field of mining engineering is so broad, and the number of subjects bearing on it so great, that no student can profitably cover all of the ground in the time usually given to a college course. Moreover, the average student possesses greater aptitude in some part or parts of this broad field than in others. If he cannot train for all of it his chances of success are manifestly greater if he devotes himself to those portions for which he is best adapted. In order that he may do this, some way must be provided whereby different students may pursue different curriculums. To meet these conditions the Michigan College of Mines has put into operation a flexible system allowing considerable range in selecting the courses or subjects which shall compose a particular student's curriculum. This does not mean that haphazard selection is allowed. A student desiring to pursue a certain line of work selects courses leading up to it, laying first a solid foundation. He is obliged to preserve the natural sequence of subjects. Having shown his bent and set out to train in accordance with it, he follows an orderly system of selection which may become more and more specialized as he nears the end of his course. This College was the first, and until very recently the only institution to offer such privileges of choice to a student of engineering. Regulations governing the choice of courses under this system are given with other regulations of the College on a subsequent page.

The methods outlined above have not been carelessly thought out nor hastily adopted. They have developed slowly in the earnest effort of those interested in, and responsible for the institution, to solve the problems presented to it, and to build up an efficient system of training mining engineers. Up to the present time they have stood the test of use very satisfactorily.

ADMISSION TO THE COLLEGE

1. Admission by Examination.

All students who desire to become candidates for a degree are admitted on examination in the following subjects:

English.—The examination in this subject is intended to test the candidate's ability to command good English. He will be required to write briefly on some subject assigned at the time.

Arithmetic and Metric System.
Bookkeeping.
Algebra, through Quadratic Equations.
Geometry—Plane, Solid and Spherical.
Physics.
Physical Geography or Elements of Astronomy.

2. Admission by Diploma.

Candidates who are graduates of the proper course of a high school accredited to this institution are admitted upon presentation of diploma, together with a record of the subjects pursued and grade obtained in each. The record presented should include all of the subjects listed under Admission by Examination. Entrance examination will be required in any of the above subjects not covered by the High School record.

Application to be placed on the accredited list may be made by the principal or superintendent of the school, who shall send to the secretary of the College a copy of the courses of study and list of text-books employed. Copies of examinations which have been set, accompanied with papers which have been written by pupils in answer thereto, must also be forwarded to the College. The subjects covered by these papers must not be less than four, including Mathematics, Physics and one other science subject. If these are satisfactory, the school will be placed provisionally upon the accredited list. The College regards the work done by graduates as ultimately the genuine test of the character of the preparation given by the high school. If therefore the students accepted from such an accredited school shall be found to be deficient in preparation, the school must expect to be dropped from the list.

OFFICERS OF ADMINISTRATION

President,	Fred Walter McNair
Secretary and Librarian,	Frances Hanna Scott
Treasurer,	Frederick William Nichols
Superintendent of Grounds,	Frederick William Sperr
Superintendent of Buildings,	Ozni Porter Hood

Eveleth High School, Eveleth, Minn.
Ferris Institute, Big Rapids.
Flint High School.
Fort Atkinson High School, Fort Atkinson, Wis.
Gladstone High School.
Grand Haven High School.
Grand Rapids Central High School.
Grass Lake High School.
Greenville High School.
Hadley High School.
Hancock High School.
Houghton High School.
Hurley High School, Hurley, Wis.
Hyde Park High School, Hyde Park, Chicago, Ill.
Ionia High School.
Iron Mountain High School.
Ironwood High School.
Ishpeming High School.
Ithaca High School.
Janesville High School, Janesville, Wis.
Johnstown High School, Johnstown, Pa.
Kalamazoo High School.
Kansas City Manual Training High School, Kansas City, Mo.
Lake Linden High School.
L'Anse High School.
Lansing High School.
Lawrenceville School, Lawrenceville, N. J.
Ludington High School.
Manistee High School.
Manistique High School.
Marinette High School, Marinette, Wis.
Marquette High School.
Menominee High School.
Michigamme High School.
Michigan Military Academy.
Milwaukee Academy, Milwaukee, Wis.
Milwaukee East Side High School, Milwaukee, Wis.
Milwaukee South Side High School, Milwaukee, Wis.
Milwaukee West Side High School, Milwaukee, Wis.

Morgan Park Academy, Morgan Park, Ill.
Muskegon High and Hackley Manual Training Schools.
Negaunee High School.
Neillsville High School, Neillsville, Wis.
Niles High School.
Northwestern Military Academy, Highland Park, Chicago, Ill.
Norway High School.
Oconto High School, Oconto, Wis.
Oshkosh High School, Oshkosh, Wis.
Owosso High School.
Petoskey High School.
Phœnix High School, Phœnix, Ariz.
Plainwell High School.
Port Huron High School.
Princeton High School, Princeton, Ind.
Racine College, Racine, Wis.
Reed City High School.
Republic High School.
Rockford High School.
Rutger's College Preparatory School, Princeton, N. J.
Ryan High School, Appleton, Wis.
Saginaw East Side High School.
Saginaw West Side High School.
St. John's Military Academy, Delafield, Wis.
St. Paul High School, St. Paul, Minn.
San Antonio Academy, San Antonio, Tex.
Sault Ste. Marie High School.
Shattuck School for Boys, Faribault, Minn.
Spokane High School, Spokane, Wash.
Steele High School, Dayton, Ohio.
Three Rivers High School.
Toledo Central High School, Toledo, Ohio.
Township High School, Evanston, Ill.
Township High School, Joliet, Ill.
Township High School, Oak Park, Ill.
Traverse City High School.
University High School, Chicago, Ill.
Wayland Academy, Beaver Dam, Wis.
Worcester Academy, Worcester, Mass.
Yale High School.

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3. Graduates of Colleges.

Graduates of approved colleges are admitted upon presentation of their diplomas, or certificates of graduation. Courses taken at the other institution which may be the equivalent of courses offered here, will be credited toward a degree, under the following conditions: After an informal discussion of the previous work, which must satisfy the instructors from whom credit is asked, as to its scope and thoroughness, provisional credits are given. If the student's subsequent work in this College is satisfactory, the provisional credits are made permanent; if unsatisfactory, the student is assigned to such courses as are necessary to make up the deficiencies. This method is considered to be fair to the student, to the college from which he came, and to this College.

4. Undergraduates of Colleges.

Undergraduates of other colleges must present certificate of honorable dismissal. Credits are given them under the same conditions as outlined for graduates.

5. Special Arrangement.

In many cases persons who have been engaged in practical work until upwards of nineteen years of age, desire to better their condition by obtaining an education which will be of practical use, but they are unable to take the time for a full high school course. Such men often prove to be among the best students, since they realize clearly the purpose of their work and the value of time. For their benefit the College will arrange with the principal or superintendent of any of its accredited schools a special course to cover a minimum of two years' work, and upon the student's completion of this course the College will accept him upon the recommendation of the principal or superintendent.

This arrangement will not be entered into for prospective students who are under nineteen years of age, and only for those over nineteen years of age who can show that they have been employed for at least two years in some position entailing responsibility. The College reserves the right to withdraw this offer at any time that it may deem best.

6. Special Students.

Persons who are not candidates for a degree, and who wish to take special studies, are permitted to do so upon giving satisfactory evidence that they are able to pursue with profit the courses they wish to take. If they subsequently desire to become candidates for a degree, they must pass the required entrance examinations.

Since its organization the College has had many students of mature age who came for certain training which they considered necessary for their subsequent work. These have proved themselves excellent workers, and the College desires to extend to such persons every possible aid. It has assisted in this way numerous practical and active business men who have had years of previous experience, and it desires to continue a work from which valuable results have been obtained in the past.

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Outline List of Courses of Instruction Arranged in Order of Sequence

A. MATHEMATICS.

Professor Fisher, Assistant Professor Grant, Messrs. Rood, Haigler, Anderson and Jordan.

A 1. Algebra.
Four times a week, seventeen weeks, and *two times a week,* sixteen weeks. To count as one credit. Messrs. Rood, Haigler, Anderson and Jordan.

A 2. Plane Trigonometry.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by, or accompanied with A 1 (Algebra). Messrs Rood, Haigler and Jordan.

A 3. Spherical Trigonometry.
Two times a week, sixteen weeks. To count as three-tenths of a credit. To be preceded by A 2 (Plane Trigonometry). Professor Fisher, Assistant Professor Grant, Messrs. Rood, Haigler and Jordan.

A 4. Analytical Geometry.
Four times a week, twenty-one weeks. To count as nine-tenths of a credit. To be preceded by A 2 (Plane Trigonometry). Assistant Professor Grant, Messrs. Rood, Haigler and Jordan.

A 5. Differential and Integral Calculus.
Four times a week, twenty-eight weeks. To count as eleven-tenths of a credit. To be preceded by A 4 (Analytical Geometry), and B 1 (Physics), and preceded by, or accompanied with B 4 (Physics). Professor Fisher and Assistant Professor Grant.

A 6. Introduction to Differential Equations.
Four times a week, five weeks. To count as two-tenths of a credit. To be preceded by A 5 (Calculus). Professor FISHER.

B. PHYSICS.

The President, Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Rood, Anderson, Jordan and Butler.

B 1. Physics.
Twelve hours a week, twenty-one weeks. To count as eight-tenths of a credit. Must be preceded by, or accompanied with A 1 (Algebra) and A 2 (Plane Trigonometry). Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, ROOD, ANDERSON, JORDAN and BUTLER.

B 4. Physics.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. Must be preceded by B 1 (Physics). Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, ROOD, ANDERSON and JORDAN.

B 2. Physical Measurements.
Twenty-four hours a week, five weeks. To count as four-tenths of a credit. Must be preceded by B 1 and B 4 (Physics). Professor FISHER and Assistant Professor GRANT.

B 5. Light.
Six hours a week, twelve weeks. To count as two-tenths of a credit. Must be preceded by B 1 (Physics). The PRESIDENT and Professor FISHER.

B 3. Electrical Measurements.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by C 1 (Analytic Mechanics). Professor FISHER and Messrs. HAIGLER and ANDERSON.

C. MECHANICS.

Professor Fisher, Assistant Professor Grant and Mr. Rood.

C 1. Analytic Mechanics.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by, or accompanied with A 5 (Calculus). Professor FISHER, Assistant Professor GRANT and Mr. ROOD.

C 2. Analytic Mechanics.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by C 1 (Analytic Mechanics). Professor FISHER and Assistant Professor GRANT.

F. CHEMISTRY.

Professor Koenig, Dr. Fernekes, Dr. Koch and Mr. Wilson.

F 1. General Experimental Chemistry.
Twelve hours a week, twenty-eight weeks. To count as eleven-tenths of a credit. Professor KOENIG and Mr. WILSON.

F 2. Blowpipe Analysis.
Twelve hours a week, five weeks. To count as two-tenths of a credit. To be preceded by F 1 (General Experimental Chemistry). Professor KOENIG, Dr. KOCH and Mr. WILSON.

F 3. Qualitative Analysis.
Twelve hours a week, twenty-eight weeks. To count as eleven-tenths of a credit. To be preceded by F 2 (Blowpipe Analysis). Professor KOENIG and Dr. KOCH.

F 4. Volumetric Analysis.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis). Professor KOENIG and Dr. FERNEKES.

F 7. Quantitative Analysis.
Twelve hours a week, twenty-one weeks. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis). Professor KOENIG and Dr. FERNEKES.

F 5. Advanced Quantitative Analysis.
Twelve hours a week, thirty-three weeks. To count as twelve-tenths of a credit. To be preceded by, or accompanied with F 7 (Quantitative Analysis). Professor KOENIG.

F 6. Synthetic and Theoretical Chemistry.
Eighteen hours a week, thirty-three weeks. To count as two credits. To be preceded by F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis), and W 3 (Mineralogy). Professor KOENIG.

G. METALLURGY.

Professor Austin, Mr. Copeland and Mr. Barabé.

G 1. Assaying.
Lectures and recitations, once a week, sixteen weeks, and one hundred twenty hours laboratory work and recitations. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis) and W 2 (Mineralogy) Professor AUSTIN and Mr. COPELAND.

G 2. Metallurgy.
Four times a week, twenty-eight weeks, and twenty-seven hours for excursions and reports on same. To count as eight-tenths of a credit. To be preceded by B 4 (Physics), F 3 (Qualitative Analysis), and preceded by, or accompanied with G 1 (Assaying) and W 2 (Mineralogy). Professor AUSTIN and Mr. COPELAND.

G 3. Metallurgical Laboratory Practice.
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis), G 1 (Assaying), and preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN and Mr. COPELAND.

G 4. Metallurgical Designing.
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy), Q 6 (Graphical Statics) and M 11 (Mechanical Engineering 11). Professor AUSTIN.

G 5. Metallurgical Organization.
Nine hours a week, twelve weeks. To count as three-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN.

G 6. Metallurgical Accounting.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN.

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G 7. Practice Work in Metallurgy.
Forty-five hours a week, three weeks. Furnace work. To count as five-tenths of a credit. To be preceded by G 3 (Metallurgical Laboratory Practice). Professor AUSTIN and Mr. COPELAND.

M. MECHANICAL ENGINEERING.

Professor Hood, Assistant Professor Christensen, Messrs. Anderson, Richards, Johnson, Freeman, Hill and Uren.

M 2. Shop Practice.
Forty-five hours a week, twelve weeks. To count as two credits. Messrs. RICHARDS and JOHNSON.

M 15. Mechanical Drawing.
Fifteen hours a week, twelve weeks. To count as six-tenths of a credit. Mr. JOHNSON, Mr. FREEMAN and Mr. HILL.

M 16. Machine Drawing.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). Mr. JOHNSON, Mr. FREEMAN and Mr. HILL.

M 1. Properties of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics) and F 1 (General Chemistry), and preceded by, or accompanied with B 4 (Physics). Assistant Professor CHRISTENSEN.

M 5. Mechanical Engineering I.
Three times a week, twelve weeks. To count as four-tenths of a credit. Professor HOOD.

M 11. Mechanical Engineering II.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. To be preceded by M 5 (Mechanical Engineering I), M 15, (Mechanical Drawing), M 1 (Properties of Materials) and M 2 (Shop Practice). Professor HOOD.

M 4. Mechanics of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by M 1 (Properties of Materials), and preceded by, or accompanied with C 2 (Analytic Mechanics). Assistant Professor CHRISTENSEN.

M 6. Testing Materials of Engineering.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 4 (Mechanics of Materials). Assistant Professor CHRISTENSEN.

M 10. Pumps and Pumping Machinery.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and preceded by, or accompanied with C 2 (Analytic Mechanics). Professor HOOD.

M 14. Air Compression and Air Machinery.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 10 (Pumps and Pumping Machinery). Professor HOOD.

M 3. Design of Structural Joints.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by, or accompanied with M 4 (Mechanics of Materials). Assistant Professor CHRISTENSEN.

M 12. Mechanical Engineering III.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and preceded by, or accompanied with C 2 (Analytic Mechanics), and fall term of M 4 (Mechanics of Materials). Professor HOOD.

M 13. Mechanical Engineering IV.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 12 (Mechanical Engineering III). Professor HOOD.

M 9. Mechanical Engineering Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 13 (Mechanical Engineering IV). Professor HOOD and Assistant Professor CHRISTENSEN.

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N. ELECTRICAL ENGINEERING.

Professor Hood and Mr. Anderson.

N 1. Electrical Engineering.
Three hours a week, twenty-three weeks. To count as seventenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and B 3 (Electrical Measurements). Mr. ANDERSON.

N 3. Electrical Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by N 1 (Electrical Engineering). Professor HOOD and Mr. ANDERSON.

Q. CIVIL ENGINEERING.

Professor Sperr and Messrs. Houle, Schubert, Langworthy, Botsford and ———.

Q 4. Topographical Drawing.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). Mr. BOTSFORD.

Q 1. Surveying (Field Work).
Fifty hours a week, twelve weeks. To count as two and two-tenths credits. To be preceded by A 3 (Spherical Trigonometry), and Q 4 (Topographical Drawing). Professor SPERR and Messrs. HOULE, SCHUBERT, LANGWORTHY and ———.

Q 5. Surveying (Office Work).
Ten hours a week, eleven weeks. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying). Mr. HOULE.

Q 6. Graphical Statics.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. To be preceded by B 1 (Physics), and M 15 (Mechanical Drawing). Messrs. SCHUBERT and LANGWORTHY.

A 6. Introduction to Differential Equations.
Four times a week, five weeks. To count as two-tenths of a credit. To be preceded by A 5 (Calculus). Professor FISHER.

B. PHYSICS.

The President, Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Rood, Anderson, Jordan and Butler.

B 1. Physics.
Twelve hours a week, twenty-one weeks. To count as eight-tenths of a credit. Must be preceded by, or accompanied with A 1 (Algebra) and A 2 (Plane Trigonometry). Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, ROOD, ANDERSON, JORDAN and BUTLER.

B 4. Physics.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. Must be preceded by B 1 (Physics). Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, ROOD, ANDERSON and JORDAN.

B 2. Physical Measurements.
Twenty-four hours a week, five weeks. To count as four-tenths of a credit. Must be preceded by B 1 and B 4 (Physics). Professor FISHER and Assistant Professor GRANT.

B 5. Light.
Six hours a week, twelve weeks. To count as two-tenths of a credit. Must be preceded by B 1 (Physics). The PRESIDENT and Professor FISHER.

B 3. Electrical Measurements.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by C 1 (Analytic Mechanics). Professor FISHER and Messrs. HAIGLER and ANDERSON.

C. MECHANICS.

Professor Fisher, Assistant Professor Grant and Mr. Rood.

C 1. Analytic Mechanics.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by, or accompanied with A 5 (Calculus). Professor FISHER, Assistant Professor GRANT and Mr. ROOD.

C 2. Analytic Mechanics.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by C 1 (Analytic Mechanics). Professor FISHER and Assistant Professor GRANT.

F. CHEMISTRY.

Professor Koenig, Dr. Fernekes, Dr. Koch and Mr. Wilson.

F 1. General Experimental Chemistry.
Twelve hours a week, twenty-eight weeks. To count as eleven-tenths of a credit. Professor KOENIG and Mr. WILSON.

F 2. Blowpipe Analysis.
Twelve hours a week, five weeks. To count as two-tenths of a credit. To be preceded by F 1 (General Experimental Chemistry). Professor KOENIG, Dr. KOCH and Mr. WILSON.

F 3. Qualitative Analysis.
Twelve hours a week, twenty-eight weeks. To count as eleven-tenths of a credit. To be preceded by F 2 (Blowpipe Analysis). Professor KOENIG and Dr. KOCH.

F 4. Volumetric Analysis.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis). Professor KOENIG and Dr. FERNEKES.

F 7. Quantitative Analysis.
Twelve hours a week, twenty-one weeks. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis). Professor KOENIG and Dr. FERNEKES.

F 5. Advanced Quantitative Analysis.
Twelve hours a week, thirty-three weeks. To count as twelve-tenths of a credit. To be preceded by, or accompanied with F 7 (Quantitative Analysis). Professor KOENIG.

F 6. Synthetic and Theoretical Chemistry.
Eighteen hours a week, thirty-three weeks. To count as two credits. To be preceded by F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis), and W 3 (Mineralogy). Professor KOENIG.

G. METALLURGY.

Professor Austin, Mr. Copeland and Mr. Barabé.

G 1. Assaying.
Lectures and recitations, once a week, sixteen weeks, and one hundred twenty hours laboratory work and recitations. To count as five-tenths of a credit. To be preceded by F 3 (Qualitative Analysis) and W 2 (Mineralogy) Professor AUSTIN and Mr. COPELAND.

G 2. Metallurgy.
Four times a week, twenty-eight weeks, and twenty-seven hours for excursions and reports on same. To count as eight-tenths of a credit. To be preceded by B 4 (Physics), F 3 (Qualitative Analysis), and preceded by, or accompanied with G 1 (Assaying) and W 2 (Mineralogy). Professor AUSTIN and Mr. COPELAND.

G 3. Metallurgical Laboratory Practice.
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis), G 1 (Assaying), and preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN and Mr. COPELAND.

G 4. Metallurgical Designing.
Nine hours a week, twenty-eight weeks. To count as nine-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy), Q 6 (Graphical Statics) and M 11 (Mechanical Engineering 11). Professor AUSTIN.

G 5. Metallurgical Organization.
Nine hours a week, twelve weeks. To count as three-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN.

G 6. Metallurgical Accounting.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy). Professor AUSTIN.

G 7. Practice Work in Metallurgy.
Forty-five hours a week, three weeks. Furnace work. To count as five-tenths of a credit. To be preceded by G 3 (Metallurgical Laboratory Practice). Professor Austin and Mr. Copeland.

M. MECHANICAL ENGINEERING.

Professor Hood, Assistant Professor Christensen, Messrs. Anderson, Richards, Johnson, Freeman, Hill and Uren.

M 2. Shop Practice.
Forty-five hours a week, twelve weeks. To count as two credits. Messrs. Richards and Johnson.

M 15. Mechanical Drawing.
Fifteen hours a week, twelve weeks. To count as six-tenths of a credit. Mr. Johnson, Mr. Freeman and Mr. Hill.

M 16. Machine Drawing.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). Mr. Johnson, Mr. Freeman and Mr. Hill.

M 1. Properties of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics) and F 1 (General Chemistry), and preceded by, or accompanied with B 4 (Physics). Assistant Professor Christensen.

M 5. Mechanical Engineering I.
Three times a week, twelve weeks. To count as four-tenths of a credit. Professor Hood.

M 11. Mechanical Engineering II.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. To be preceded by M 5 (Mechanical Engineering I), M 15, (Mechanical Drawing), M 1 (Properties of Materials) and M 2 (Shop Practice). Professor Hood.

M 4. Mechanics of Materials.
Three times a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by M 1 (Properties of Materials), and preceded by, or accompanied with C 2 (Analytic Mechanics). Assistant Professor CHRISTENSEN.

M 6. Testing Materials of Engineering.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 4 (Mechanics of Materials). Assistant Professor CHRISTENSEN.

M 10. Pumps and Pumping Machinery.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and preceded by, or accompanied with C 2 (Analytic Mechanics). Professor HOOD.

M 14. Air Compression and Air Machinery.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 10 (Pumps and Pumping Machinery). Professor HOOD.

M 3. Design of Structural Joints.
Fifteen hours a week, eleven weeks. To count as six-tenths of a credit. To be preceded by, or accompanied with M 4 (Mechanics of Materials). Assistant Professor CHRISTENSEN.

M 12. Mechanical Engineering III.
Three times a week, twelve weeks. To count as four-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and preceded by, or accompanied with C 2 (Analytic Mechanics), and fall term of M 4 (Mechanics of Materials). Professor HOOD.

M 13. Mechanical Engineering IV.
Three times a week, ten weeks. To count as three-tenths of a credit. To be preceded by M 12 (Mechanical Engineering III). Professor HOOD.

M 9. Mechanical Engineering Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by M 13 (Mechanical Engineering IV). Professor HOOD and Assistant Professor CHRISTENSEN.

N. ELECTRICAL ENGINEERING.

Professor Hood and Mr. Anderson.

N 1. Electrical Engineering.
Three hours a week, twenty-three weeks. To count as seven-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and B 3 (Electrical Measurements). Mr. ANDERSON.

N 3. Electrical Laboratory Practice.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by N 1 (Electrical Engineering). Professor HOOD and Mr. ANDERSON.

Q. CIVIL ENGINEERING.

Professor Sperr and Messrs. Houle, Schubert, Langworthy, Botsford and ———.

Q 4. Topographical Drawing.
Fifteen hours a week, five weeks. To count as three-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). Mr. BOTSFORD.

Q 1. Surveying (Field Work).
Fifty hours a week, twelve weeks. To count as two and two-tenths credits. To be preceded by A 3 (Spherical Trigonometry), and Q 4 (Topographical Drawing). Professor SPERR and Messrs. HOULE, SCHUBERT, LANGWORTHY and ———.

Q 5. Surveying (Office Work).
Ten hours a week, eleven weeks. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying). Mr. HOULE.

Q 6. Graphical Statics.
Twelve hours a week, twelve weeks. To count as five-tenths of a credit. To be preceded by B 1 (Physics), and M 15 (Mechanical Drawing). Messrs. SCHUBERT and LANGWORTHY.

W. MINERALOGY.

Professor Seaman, Messrs. Hancock, Bowen, Hitchcock and Newton.

W 4. Elementary Mineralogy and Crystallography.

Fourteen hours a week, twelve weeks, and *three hours a week,* for sixteen weeks. To count as eight-tenths of a credit. Professor SEAMAN, and Messrs. BOWEN and HITCHCOCK.

W 1. Crystallography.

Nine hours a week, twelve weeks. To count as four-tenths of a credit. To be preceded by, or accompanied with W 4 (Elementary Mineralogy and Crystallography). Professor SEAMAN, and Messrs. HANCOCK and HITCHCOCK.

W 2. Mineralogy.

Twelve hours a week, sixteen weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics), F 2 (Blowpipe Analysis), W 1 (Crystallography) and Y 1 (Principles of Geology). Messrs. HANCOCK, HITCHCOCK, and NEWTON.

W 3. Advanced Mineralogy.

Six hours a week, twenty-three weeks. To count as five-tenths of a credit. To be preceded by W 2 (Mineralogy), and accompanied with X 2 (Petrography). Professor SEAMAN, and Messrs. BOWEN, HANCOCK and HITCHCOCK.

X. PETROGRAPHY.

Mr. Bowen and Mr. Grant.

X 1. Petrography.

Five hours a week, twelve weeks, and *twelve hours a week,* sixteen weeks. To count as eight-tenths of a credit. To be preceded by Y 1 (Principles of Geology), and preceded by, or accompanied with B 5 (Light) and W 4 (Elementary Mineralogy and Crystallography). Messrs. BOWEN and GRANT.

X 2. Advanced Petrography.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by X 1 (Petrography), and accompanied with W 3 (Mineralogy). Messrs. BOWEN and GRANT.

Y. GEOLOGY.

Professor Seaman, and Messrs. Bowen, Hancock, Grant and Hitchcock.

Y 1. Principles of Geology.
Two times a week, twelve weeks, and *one time a week,* sixteen weeks. To count as four-tenths of a credit. To be preceded by, or to accompany, W 4 (Elementary Mineralogy and Crystallography). This subject is required of all candidates for B.S. and E.M. degrees. Professor SEAMAN, and Messrs. BOWEN, HANCOCK, GRANT and HITCHCOCK.

Y 6. Applied and Mining Geology.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by W 4 (Elementary Mineralogy and Crystallography), and Y 1 (Principles of Geology). Mr. BOWEN.

Y 7. Field Geology.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by R 1 (Principles of Mining), W 4 (Elementary Mineralogy and Crystallography) and Y 1 (Principles of Geology). Professor SEAMAN, and Messrs. BOWEN HANCOCK, HITCHCOCK and GRANT.

Y 3. Physical and Chemical Geology.
Two times a week, sixteen weeks. To count as four-tenths of a credit. To be preceded by W 2 (Mineralogy), and preceded by, or accompanied with X 1 (Petrography). Professor SEAMAN.

Y 2. Historical Geology.
Four times a week, sixteen weeks. To count as six-tenths of a credit. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology). Professor SEAMAN and Mr. HANCOCK.

W. MINERALOGY.

Professor Seaman, Messrs. Hancock, Bowen, Hitchcock and Newton.

W 4. Elementary Mineralogy and Crystallography.

Fourteen hours a week, twelve weeks, and *three hours a week,* for sixteen weeks. To count as eight-tenths of a credit. Professor SEAMAN, and Messrs. BOWEN and HITCHCOCK.

W 1. Crystallography.

Nine hours a week, twelve weeks. To count as four-tenths of a credit. To be preceded by, or accompanied with W 4 (Elementary Mineralogy and Crystallography). Professor SEAMAN, and Messrs. HANCOCK and HITCHCOCK.

W 2. Mineralogy.

Twelve hours a week, sixteen weeks. To count as seven-tenths of a credit. To be preceded by B 1 (Physics), F 2 (Blowpipe Analysis), W 1 (Crystallography) and Y 1 (Principles of Geology). Messrs. HANCOCK, HITCHCOCK, and NEWTON.

W 3. Advanced Mineralogy.

Six hours a week, twenty-three weeks. To count as five-tenths of a credit. To be preceded by W 2 (Mineralogy), and accompanied with X 2 (Petrography). Professor SEAMAN, and Messrs. BOWEN, HANCOCK and HITCHCOCK.

X. PETROGRAPHY.

Mr. Bowen and Mr. Grant.

X 1. Petrography.

Five hours a week, twelve weeks, and *twelve hours a week,* sixteen weeks. To count as eight-tenths of a credit. To be preceded by Y 1 (Principles of Geology), and preceded by, or accompanied with B 5 (Light) and W 4 (Elementary Mineralogy and Crystallography). Messrs. BOWEN and GRANT.

X 2. Advanced Petrography.
Nine hours a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by X 1 (Petrography), and accompanied with W 3 (Mineralogy). Messrs. BOWEN and GRANT.

Y. GEOLOGY.

Professor Seaman, and Messrs. Bowen, Hancock, Grant and Hitchcock.

Y 1. Principles of Geology.
Two times a week, twelve weeks, and *one time a week,* sixteen weeks. To count as four-tenths of a credit. To be preceded by, or to accompany, W 4 (Elementary Mineralogy and Crystallography). This subject is required of all candidates for B.S. and E.M. degrees. Professor SEAMAN, and Messrs. BOWEN, HANCOCK, GRANT and HITCHCOCK.

Y 6. Applied and Mining Geology.
Three times a week, sixteen weeks. To count as five-tenths of a credit. To be preceded by W 4 (Elementary Mineralogy and Crystallography), and Y 1 (Principles of Geology). Mr. BOWEN.

Y 7. Field Geology.
Forty-five hours a week, six weeks. To count as one credit. To be preceded by R 1 (Principles of Mining), W 4 (Elementary Mineralogy and Crystallography) and Y 1 (Principles of Geology). Professor SEAMAN, and Messrs. BOWEN HANCOCK, HITCHCOCK and GRANT.

Y 3. Physical and Chemical Geology.
Two times a week, sixteen weeks. To count as four-tenths of a credit. To be preceded by W 2 (Mineralogy), and preceded by, or accompanied with X 1 (Petrography). Professor SEAMAN.

Y 2. Historical Geology.
Four times a week, sixteen weeks. To count as six-tenths of a credit. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology). Professor SEAMAN and Mr. HANCOCK.

Y 4. Geological Field Work.

Forty-five hours a week, six weeks. To count as one credit. To be preceded by Q 1 (Surveying), and Y 2 (Historical Geology). Professor SEAMAN, and Messrs. BOWEN, HANCOCK, GRANT and HITCHCOCK.

Y 5. Economic Geology.

Three times a week, twenty-eight weeks. To count as nine-tenths of a credit. To obtain credit in this subject, it is necessary to have credit in W 3 (Mineralogy), X 2 (Petrography), and Y 4 (Geological Field Work). Messrs. BOWEN and HANCOCK.

J. THESIS.

The Faculty.

J 1. Thesis.

Properly qualified students may include the preparation of a thesis in their work for a degree. To count as one credit.

PHYSICAL TRAINING.

Mr. Stewart.

The gymnasium floor is open from eight A. M. to ten P. M., six days per week.

Class or individual instruction by arrangement with the instructor. Open to all students.

Departments of Instruction

A. MATHEMATICS.

Professor Fisher, Assistant Professor Grant, Messrs. Rood, Haigler, Anderson and Jordan.

As will be seen by a detailed examination of the following pages, the subjects of this department form the necessary foundation for a great part of the student's subsequent work; and they are given as a preparation for this work, as well as for their value in actual engineering practice, and in affording mental discipline.

It is the intention, therefore, to give the instruction in this department in such a manner as will make prominent those subjects or portions of subjects which will be of actual use to the student, and, later, to the engineer. The value of the study of mathematics in developing the power to do vigorous and logical thinking is not underestimated, but it is thought that the effort to master the logic of the subjects necessary to the engineer will afford the student ample opportunity to develop this power.

Every effort is made to see that the student takes advantage of the opportunity thus offered. At each step of his progress he is required to think. The ability to describe a given method, or to correctly quote a given formula, and to apply either to a given case, is in no instance accepted as sufficient. The student is required to logically derive the method of formula, and to demonstrate its correctness.

The courses offered in mathematics are the following:

A 1. Algebra.

Messrs. Rood, Haigler, Anderson and Jordan.

The course includes the Theory of Limits, Logarithms, Progressions, Binomial Theorem, Undetermined Co-efficients. Series and the solution of higher equations. Special attention is paid to the slide rule, graphical solutions, and practical applications. Wentworth's College Algebra is used as the text book.

Four times a week, seventeen weeks, fall term and last half of spring term, and *two times a week*, winter term and first half of spring term. To count as one credit.

A 2. Plane Trigonometry.

Messrs. ROOD, HAIGLER and JORDAN.

The ratio system is used exclusively, and prominence is given to the solution of trigonometric equations, and the transformation of trigonometric expressions. The fall term's work in A 1 (Algebra) must precede or be taken along with this course. Well's Plane and Spherical Trigonometry is used as the text book.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit.

A 3. Spherical Trigonometry.

Professor FISHER, Assistant Professor GRANT, Messrs. ROOD, HAIGLER and JORDAN.

Under this head is given the solution of Right and Oblique spherical triangles with application to the problems of Spherical Astronomy, such as the student will need in his surveying.

The text used is the same as A 2 (Plane Trigonometry), supplemented with notes issued by the department.

Two times a week, sixteen weeks, winter term, and first five weeks of the spring term. To count as three-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry).

A 4. Analytic Geometry.

Assistant Professor GRANT, Messrs. ROOD, HAIGLER and JORDAN.

The course covers the straight line, conic sections, a few higher plane curves, transformation of co-ordinates, general equations of the second degree, and an introduction to geometry of three dimensions. The object is to familiarize the student with methods rather than with any set of curves. Given partly by lectures and partly from Tanner & Allen's Analytic Geometry.

Four times a week, twenty-one weeks, winter and spring terms. To count as nine-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry), and preceded by, or accompanied with A 1 (Algebra).

A 5. Differential and Integral Calculus.

Professor FISHER and Assistant Professor GRANT.

The Differential Calculus is developed from a rate as its fundamental notion. The Integral Calculus is from the beginning treated as a method of summation. The object of the course is to give the student a thorough working knowledge of the subject, to put him in possession of a tool of which he can afterward make efficient use. It is believed that this can best be accomplished by giving him a rigorously logical basis for his methods and formulas; and the attempt to do this is therefore made. Applications of differentiation to Expansion in Series, Indeterminate Forms, Maxima and Minima, etc., are treated; while problems of Area, Volume, Work, Pressure, etc., introduce the subject of integration, and their treatment is carried along simultaneously with that of methods. Approximate methods of integration, including the polar planimeter, receive particular attention.

The calculus is given by lectures, with printed notes, and Taylor's Differential and Integral Calculus as a text book. *Four times a week,* twenty-eight weeks, fall, winter and first half of spring terms. To count as eleven-tenths of a credit. Must be preceded by A 4 (Analytic Geometry), and B 1 (Physics), and preceded by, or accompanied with B 4 (Physics).

A 6. Introduction to Differential Equations.

Professor FISHER.

An introduction to Differential Equations, which includes the treatment of those special equations which the student will meet in his study of Mechanics and Electricity.

The course is given by lectures and recitations. *Four times a week,* last five weeks of the spring term. To count as two-tenths of a credit. Open to those who have credit for A 5 (Calculus).

B. PHYSICS.

The President, Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Rood, Anderson, Jordan and Butler.

The aim in the department of Physics, as in that of Mathematics, is to select such objects as have, directly or indirectly, a bearing

on the practical work of the mining engineer, and to treat these in as practical a manner as possible. The instruction is given by the laboratory method. The student goes at once into the laboratory, and there, under the direction of the instructors, experiments for himself. The experiments are mostly quantitative.

So far as possible, mere mechanical following of direction is excluded, and intelligent thinking is made necessary to the accomplishment of the work. Every effort is put forth to have the student clearly develop and fix in his mind the principles of Physics which he will afterward use, and also to lay the foundation for that skill in accurate determination of quantity and care of delicate apparatus which are needed by the practical engineer. Accuracy and order are insisted on from the first. Each student receives individual attention, and, with the exception of a few experiments requiring more than one observer, he does his work independently of all other students.

The work of the laboratory is accompanied by illustrated lectures, and by text-book and recitation work.

The department is equipped with a good assortment of modern apparatus for lecture illustration and individual experiment.

B 1. General Physics.

Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, ROOD, ANDERSON, JORDAN and BUTLER.

An elementary course including Mechanics, Heat and Light. Lecture, recitation and laboratory work proceed together throughout the course. The geometrical side of Light is developed mostly in the laboratory, the wave theory in the lecture room with the optical lantern and the arc light.

Twelve hours a week, twenty-one weeks, winter and spring terms. To count as eight-tenths of a credit. Must be preceded by, or accompanied with A 1 (Algebra) and A 2 (Plane Trigonometry).

B 2. Physical Measurements.

Professor FISHER and Assistant Professor GRANT.

A more advanced course in measurements of precision, open to those who have taken B 1 and B 4 (Physics). The work offered will be mainly in the determination of densities, moments of inertia,

calorimetry and photometry. Each student will work independently of all others, and to a considerable extent the choice of the line of work he is to pursue will lie with him. Text books are Nichol's Manual of Laboratory Physics, and Stewart and Gee's Elementary Practical Physics, Vols. I and III.

Twenty-four hours a week, last five weeks of the spring term. To count as four-tenths of a credit.

B 3. Electrical Measurements.

Professor FISHER, Messrs. HAIGLER and ANDERSON.

The increasing use of electricity in mining and related industries has caused the Michigan College of Mines to give particular attention to this subject.

This course is offered to those who are making Electrical Engineering their principal subject, to those who intend taking up Electrolytic or Electro-metallurgical work, and to any others who wish to become familiar with those modern methods of electrical measurement necessary wherever there is made any practical application of this agent.

In the course are included the measurement of Current, Resistance, Potential Difference, Electromotive Force, Quantity, Capacity, Mutual and Self Induction, Strength of Field, etc.

In the lecture room the theory of a given measurement is taken up; then the construction and calibration of the instrument used in the measurement are studied, the instrument being at hand for inspection; and, finally, in the laboratory, the student calibrates, if necessary, and uses the instrument in making the measurement.

Examples of all the principal instruments used in modern electrical methods are owned by this institution, and are available for the work of this course.

The text books are Carhart and Patterson's Electrical Measurements, and Nichol's Laboratory Manual.

Nine hours a week, sixteen weeks in the winter term, and first five weeks of spring term. To count as five-tenths of a credit. To be preceded by C 1 (Analytic Mechanics).

B 4. General Physics.

Professor FISHER, Assistant Professor GRANT, Messrs. HAIGLER, ROOD, ANDERSON and JORDAN.

Subject B 4 continues the work begun in B 1, and includes Heat and an elementary course in Magnetism and Electricity. Text books used are Glazebrook's Heat, printed notes on Magnetism and Electricity, and Jackson's Electricity and Magnetism.

Twelve hours a week, twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics).

B 5. Light.

The PRESIDENT and Professor FISHER.

A more advanced course continuing the work begun in this subject in B 1 (Physics). The course is designed particularly for those students who desire to take up Petrography. It deals chiefly with polarization. The subject is presented by experimental lectures which are followed up with individual experiment. A very complete outfit of projection apparatus made by Newton & Co., London, is in the possession of the department for use in this course.

Six hours a week, twelve weeks, fall term. To count as two-tenths of a credit. To be preceded by B 1 (Physics).

C. MECHANICS.

Professor Fisher, Assistant Professor Grant and Mr. Rood.

An attempt is made in Mechanics to develop the essential principles, and to render the student proficient in applying them to practical rather than theoretical problems. To this end a large number of problems are solved which, so far as possible, are selected from machines or structures with which the student is already familiar, or the study of which he is subsequently to take up.

C 1. Analytic Mechanics.

Professor FISHER, Assistant Professor GRANT and Mr. ROOD.

Church's Mechanics of Engineering, Parts I and II, Statics and Dynamics, is made the basis of this and the following course.

Subject C 1 occupies three hours in class room and three in the laboratory each week for sixteen weeks, in the winter term and first half of spring term. To count as five-tenths of a credit.

To be preceded by, or accompanied with A 5 (Calculus).

C 2. Analytic Mechanics.

Professor FISHER and Assistant Professor GRANT.

Subject C 2 continues the work begun in C 1, and is given three hours in class room and three in the laboratory each week, twelve weeks, in the fall term. To count as four-tenths of a credit.

To be preceded by C 1 (Analytic Mechanics).

F. CHEMISTRY.

Professor Koenig, Dr. Fernekes, Dr. Koch and Mr. Wilson.

Equipment.

The *Laboratory for General and Experimental Chemistry* is a room 31½ x 51 feet, situated in the basement of the northeast wing of the chemistry building. The room receives light from three of its sides. Five desks provide table and closet space for ninety students. A continuous hood runs around three walls of the room with a total length of 102 feet, enabling forty-five students to make use of the hood at one time. The north wall hood is six feet high and is made fire proof. Here all experiments requiring high temperature are performed in wind furnaces, muffle furnaces and gas furnaces. The instructor's private room opens into the main laboratory. Another adjoining room contains all the special apparatus, which is accessible to the students through the instructor.

The *Laboratory for Qualitative Analysis* occupies the west wing of the main floor. The room is 40 x 33 feet. Five desks give working and closet space for sixty-four students, with one sink for four places. A continuous hood runs along three of the walls. This hood is divided into compartments of five feet each, to be occupied by one or two students at a time. Each compartment contains two permanent self-supplying water-baths and two gas stop-cocks. Four of the compartments have two Koenig's Hydrogen-sulfid generators, each permanently mounted. The hoods are supplied with mains for water, gas and compressed air, the latter to be used chiefly for rapid evaporation on the water baths; from each compartment the foul gases and vapors are drawn by fan-suction, whilst a large volume of fresh air of the proper temperature is constantly blown into the room by a pressure fan. A dark room for spectroscopic work, and the instructor's office, open into this laboratory.

The *Laboratory for Quantitative Analysis* occupies the east wing of the main floor. It is 39½ x 33 feet. Four desks accommodate forty students, allowing each man four feet, and a sink for every four men. A hood runs along each of the long sides, divided into compartments and furnished the same as in the Qualitative Laboratory, except that two compartments only contain Koenig's Hydrogen-sulfid generators, whilst two other compartments are furnished each with a Koenig's Chlorine and Hydrogen generator, a combustion furnace and a Shimer apparatus for carbon determinations. The weighing room opens directly into the laboratory, but it has exclusive northern light. It is furnished with twelve analytical balances of the best make; one for four students. The laboratory for *Gas Analysis* is located alongside of the weighing room. It has light from the north only and can be kept at a uniform temperature. It is furnished with Hempel's and Bunsen's apparatus, both for working over water and working over mercury. The instructor's office and the *Electrolytic* room adjoin the laboratory on the south wall. The electrolytic room contains desks for electrolytic determinations with six working spaces, each of which is furnished with a separate resistance, a voltmeter and a milli-am-meter. In this room is the Glass-Blower's table.

The *Laboratory for Advanced Quantitative Analysis* has working facilities for eight students. But there is a laboratory for special work in which synthetic work and research work can be carried on by a few students. This laboratory is located alongside the professor's office on the main floor.

The class instruction is given in a spacious lecture room, which is located at the east end of the second floor. This room seats 132 students in nine rows, each row being three inches higher than the preceding one. The lecture desk is furnished in the modern manner, with the electric current, and switch-board arrangements, also with water, gas and compressed air. The desk is unobstructed by any hood. Experiments generating noxious gases are carried on in a hood which stands in the adjoining preparation room behind a movable glass panel. When the latter is raised the apparatus under the hood will be visible from all parts of the room. Provision is made for the display of charts and diagrams in front of and above the black-boards behind the lecture table.

The supply clerk's office and store-rooms are located in the basement, but are connected with the main floor by means of a dumb waiter.

F 1. General Experimental Chemistry.

Professor Koenig and Mr. Wilson.

Twelve hours a week, twenty-eight weeks, fall, winter and first half of spring terms; one recitation, three lectures, and six hours of laboratory work each week; to count as eleven-tenths of a credit.

The instruction in this subject covers the following ground:

First. Experiments with the common metals, their action when heated in air, and when heated in the absence of air; discovery of the composite nature of air; a life sustaining part (ozone); a life destroying part (azote). Specific gravity of azote by direct weight and of ozone by calculation. The increase in weight of metals when heated in air, discovery of ozonites (oxides.) Ratio of increase. Burning of sulphur in air, discovery of a gaseous sulphur ozonite possessing an acid taste; change of the name ozone into oxygen. Restoration of the original metals from the oxyds by the action of charcoal; hence the notion of elements or simple bodies. Action of the common metals at a red heat upon steam, the forming of bodies similar to the oxides and of an inflammable gas; discovery of hydrogen and its properties. Proving the identity of water oxides with air oxides, hence the conclusion that water is a combination of oxygen with hydrogen.

Second. (1) The study of copperas or vitriol. Under the action of heat it yields an oily liquid—the oil of vitriol. Correlation of this body with sulphur oxide. With the oil of vitriol the student has gained now a powerful reagent, but he does not know, and should not be told at this stage of his development that this oil of vitriol is $H^2\ SO^4$. The body is for his purposes simply oil of vitriol, for which the symbol Ov may stand.

(2) Study of potash, soda ash, limestone. Their action with heat, with heat and charcoal, with oil of vitriol. Their action upon each other; of burnt lime upon potash. Discovery of potassium, sodium, calcium, of caustic soda, caustic potash, and of a non-life-sustaining, heavy, slightly sour gas, lime gas (not CO_2). Alkaline reaction, acid reaction; the notion of hydroxides, of acid hydroxides and of basic hydroxides.

(3) Study of common salt, the mother-liquor salt, and the varec salt; the spirits of salt. Decomposition into a green gas and hydrogen. Chlorine, probably a simple body. Bromine, iodine, fluorine. Action of chlorine upon hydrogen in equal volumes. The theory of combinations by volumes; the notion of *molecules* and *atoms;* of molecular weights and atomic weights. The action of chlorine upon the common metals—the chlorides, their properties. Reproduction of salt by acting with spirits of salt upon soda-ash—hence the identity of the metal in salt and soda-ash. Atomic weight of sodium and potassium by experiment.

(4) The study of nitre. Action in heat. Yields a gas which sustains combustion and animal breathing. Identification of this gas with the ozone or oxygen of the air. The notion of super or peroxides. The spirits of nitre. Its action upon the metals. Discovery of nitrogen and identification of this gas with the ozote of the air. The several oxides of nitrogen. Nitrogen chloride. Action of zinc and caustic potash upon nitre. Discovery of gaseous alkaline body: Ammonia. Study of its properties and combinations; ammonium salts.

(5) The study of sulphur. The oxides and chlorides of sulphur. The manufacture of hydrogen sulphate.

(6) Discovery of carbon by decomposing the limestone gas with sodium. Identification of this body with the substance of charcoal, of mineral coal, of plant and animal structures. The mineral oils, the natural gases. The fats, alcohols, ethers, albumenoid bodies. Discovery of cyanogen and its principal compounds.

(7) The study of bone-ash and discovery of phosphorus-oxides and hydroxides of phosphorus.

(8) The study of borax and quartz; borum and silicon.

(9) Theoretical deductions. Electrolysis. Thermo-chemistry. Structural and stereographic formulæ.

The students may take notes during the lectures but are not *required* to do so, so that the whole attention can be given to the following of the manipulation in the experiments.

F 2. Blowpipe Analysis.

Professor Koenig, Dr. Koch and Mr. Wilson.

Twelve hours a week, five weeks, last half of spring term. Two lectures, one recitation and eight hours of laboratory work each

week. To count as two-tenths of a credit. The lectures are merely a continuous set of demonstrations by the professor to show how the reactions should be made.

This is a short course in Qualitative Analysis in which preference is given to reaction in the igneous way, so that students may be enabled to take the course in Mineralogy with full benefit.

Brush's tables and Landauer's small treatise are referred to.

To be preceded by F 1 (General Chemistry).

F 3. Qualitative Analysis.

Professor KOENIG and Dr. KOCH.

Twelve hours a week, twenty-eight weeks, fall, winter and first half of spring terms. Two lectures, one recitation and eight hours of laboratory work each week. To count as eleven-tenths of a credit. To be preceded by F 2 (Blowpipe Analysis).

This course embraces the chemistry of the metals and their technically important salts. In the case of gold, for instance, the student receives 200 mgrs. of the pure metal and after having converted it into the prescribed compounds and studied the reactions, he must return the gold as pure metal. As this is time-taking the course has been extended beyond the usual limit.

F 4. Volumetric Analysis.

Professor KOENIG and Dr. FERNEKES.

Twelve hours a week, for twelve weeks, fall term. To count as five-tenths of a credit. Two lectures and one recitation a week. To be preceded by F 3 (Qualitative Analysis).

The course comprises: Alkalimetry, acidemetry. Volumetric analysis of limestone and marl. Analysis of copper ores by gravimetric, volumetric, colorimetric and electrolytic methods in order that the student may learn their relative merits. Permanganate, dichromate and iodometric methods.

Sutton's Volumetric Analysis for reference.

F 5. Advanced Quantitative Analysis.

Professor KOENIG.

Twelve hours a week, thirty-three weeks, fall, winter and spring terms. One lecture, one recitation and eight hours of laboratory work a week. To count as twelve-tenths of a credit.

This course embraces: the analysis of fats, oils and soaps; the extraction and estimation of poisons; the analysis of fertilizers; the analysis of explosives; the estimation and separation of the rare elements in minerals; analysis of samarskite; nitrometry, and oxygenometry. Gas Analysis, according to Bunsen, Hempel and Winkler. Theoretical chemistry.

To be preceded by, or accompanied with F 7 (Quantitative Analysis).

F 6. Synthetic and Theoretical Chemistry.

Professor KOENIG.

Eighteen hours a week, thirty-three weeks, fall, winter and spring terms. To count as two credits. Candidates must have completed F 7 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis) and W 3 (Mineralogy).

This course is intended as an amplification of the course in General Chemistry, to cultivate the field of original discovery and invention; to produce with known reactions a desired commercial result. The modern theories based upon the physico-chemical researches of late years are to be fully discussed and compared with former notions upon the constitution of chemical compounds. Students who wish to take this course must have shown by their previous work that they possess the required originality of mind and practical sense. To all others it is a waste of time. The students are required to read much chemical literature and [illegible] their reading in a seminar to be [illegible]nted from time [illegible] subjects of experimentation [illegible] originate [illegible] or may be suggested by t[illegible]

The student must [illegible] account [illegible] arranging the apparatu[illegible] the act[illegible] the latter be a failur[illegible]

F 7. Quantitati[illegible]

Twelve [illegible] terms; tw[illegible] tenths o[illegible]

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[illegible]

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Four times a week, seventeen weeks, fall term and last half of spring term, and *two times a week*, winter term and first half of spring term. To count as one credit.

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Messrs. Rood, Haigler and Jordan.

The ratio system is used exclusively, and prominence is given to the solution of trigonometric equations, and the transformation of trigonometric expressions. The fall term's work in A 1 (Algebra) must precede or be taken along with this course. Well's Plane and Spherical Trigonometry is used as the text book.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit.

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Under this head is given the solution of Right and Oblique spherical triangles with application to the problems of Spherical Astronomy, such as the student will need in his surveying.

The text used is the same as A 2 (Plane Trigonometry), supplemented with notes issued by the department.

Two times a week, sixteen weeks, winter term, and first five weeks of the spring term. To count as three-tenths of a credit. Must be preceded by A 2 (Plane Trigonometry).

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Assistant Professor Grant, Messrs. Rood, Haigler and Jordan.

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Professor FISHER and Assistant Professor GRANT.

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A 6. Introduction to Differential Equations.

Professor FISHER.

An introduction to Differential Equations, which includes the treatment of those special equations which the student will meet in his study of Mechanics and Electricity.

The course is given by lectures and recitations. *Four times a week,* last five weeks of the spring term. To count as two-tenths of a credit. Open to those who have credit for A 5 (Calculus).

B. PHYSICS.

The President, Professor Fisher, Assistant Professor Grant, Messrs. Haigler, Rood, Anderson, Jordan and Butler.

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Twelve hours a week, twenty-one weeks, winter and spring terms. To count as eight-tenths of a credit. Must be preceded by, or accompanied with A 1 (Algebra) and A 2 (Plane Trigonometry).

B 2. Physical Measurements.

Professor FISHER and Assistant Professor GRANT.

A more advanced course in measurements of precision, open to those who have taken B 1 and B 4 (Physics). The work offered will be mainly in the determination of densities, moments of inertia,

calorimetry and photometry. Each student will work independently of all others, and to a considerable extent the choice of the line of work he is to pursue will lie with him. Text books are Nichol's Manual of Laboratory Physics, and Stewart and Gee's Elementary Practical Physics, Vols. I and III.

Twenty-four hours a week, last five weeks of the spring term. To count as four-tenths of a credit.

B 3. Electrical Measurements.

Professor FISHER, Messrs. HAIGLER and ANDERSON.

The increasing use of electricity in mining and related industries has caused the Michigan College of Mines to give particular attention to this subject.

This course is offered to those who are making Electrical Engineering their principal subject, to those who intend taking up Electrolytic or Electro-metallurgical wôrk, and to any others who wish to become familiar with those modern methods of electrical measurement necessary wherever there is made any practical application of this agent.

In the course are included the measurement of Current, Resistance, Potential Difference, Electromotive Force, Quantity, Capacity, Mutual and Self Induction, Strength of Field, etc.

In the lecture room the theory of a given measurement is taken up; then the construction and calibration of the instrument used in the measurement are studied, the instrument being at hand for inspection; and, finally, in the laboratory, the student calibrates, if necessary, and uses the instrument in making the measurement.

Examples of all the principal instruments used in modern electrical methods are owned by this institution, and are available for the work of this course.

The text books are Carhart and Patterson's Electrical Measurements, and Nichol's Laboratory Manual.

Nine hours a week, sixteen weeks in the winter term, and first five weeks of spring term. To count as five-tenths of a credit. To be preceded by C 1 (Analytic Mechanics).

This course has been arranged to emphasize the particular requirements of the mining engineer, as well as for those who are intending to specialize in metallurgy.

The instruction covers the following subjects:

(1) *Ores,* their characteristics, classification and qualities.

(2) *Sampling* of ores and products.

(3) *Preparation of Ores.* Crushing, crushing machinery, and the kinds and fineness of crushing.

(4) *Combustion, Fuels,* natural and artificial, manufacture of fuels, gas producers and apparatus.

(5) *Roasting of Ores and Roasting Furnaces and the Chemistry of Roasting.*

(6) *Refractory materials,* basic, neutral and acid and their application.

(7) *Gold.* Roasting, Cyaniding, Chlorination.

(8) *Silver.* Ores and their occurrence. Roasting, Hyposulphite leaching, Russell process. Cyaniding of silver ores.

(9) *Iron.* Blast furnace production of pig iron. Ores of iron, blast furnace and accessories, blast furnace reactions, calculation of furnace charges, pig iron.

(10) *Copper* (with accompanying gold and silver). Ores of copper. Roasting, blast furnace matte smelting, pyritic smelting, reverberatory matte smelting. Smelting of oxidized copper ores to pig copper. Refining to blister copper. Copper converting. Hydrometallurgy of copper.

(11) *Lead* (with gold, silver and copper). Lead and other ores, classification and sampling of ores. Crushing, roasting and bedding ores. Smelting ores for lead only. Blast furnace smelting with lead as collector. Calculation of charges. Furnace products and their treatment. Costs in smelting.

(12) *Zinc.* Ores of zinc. Roasting. Retorting and furnaces.

(13) *Refining* of crude metals and products of ore reduction. Refining base bullion, of matte and blister copper, of gold and silver bullion, of pig iron into steel and wrought iron.

(14) *Commercial aspects of the treatment of ores.* Prices and marketing, sampling, assaying and grading. Labor and prices. Management of labor (American, Mexican and other). Rules of

works. Skilled and unskilled labor. Duties of office force. Discipline. Pay and salaries. Supplies, accounts, estimates and costs.

(15) *Estimates,* of works or plants, operations and profits. Values of ores.

G 3. Metallurgical Laboratory Practice.

Professor AUSTIN and Mr. COPELAND.

Nine hours a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. To be preceded by F 4 (Volumetric Analysis) and G 1 (Assaying), and preceded by, or accompanied with G 2 (Metallurgy).

The instruction will comprise recitations and laboratory work as follows:

Amalgamation of ores of gold and silver.
Leaching methods for the extraction of gold, silver and copper.
Pyrometry.
Manufacture and properties of refractory materials.
Properties of copper.
Roasting, oxidizing, chloridizing and sulphurating.
Lead refining, separation and refining of silver and gold.
Retorting of zinc ores.
Obtaining data for and calculation of furnace heat equations.
Metallurgical calculations.

G 4. Metallurgical Designing.

Professor AUSTIN.

Nine hours a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy), Q 6 (Graphic Statics) and M 11 (Mechanical Engineering II.).

The work is mostly in the drawing room with reference to books, catalogues, drawings, models and the actual machines and plants. Students are taught to take full and accurate notes and to work therefrom. They make the needed calculations and study the design and operation of furnaces, etc. They also work on the design and equipment of metallurgical plants, and make estimates of their cost.

The *Laboratory for Quantitative Analysis* occupies the east wing of the main floor. It is 39½ x 33 feet. Four desks accommodate forty students, allowing each man four feet, and a sink for every four men. A hood runs along each of the long sides, divided into compartments and furnished the same as in the Qualitative Laboratory, except that two compartments only contain Koenig's Hydrogen-sulfid generators, whilst two other compartments are furnished each with a Koenig's Chlorine and Hydrogen generator, a combustion furnace and a Shimer apparatus for carbon determinations. The weighing room opens directly into the laboratory, but it has exclusive northern light. It is furnished with twelve analytical balances of the best make; one for four students. The laboratory for *Gas Analysis* is located alongside of the weighing room. It has light from the north only and can be kept at a uniform temperature. It is furnished with Hempel's and Bunsen's apparatus, both for working over water and working over mercury. The instructor's office and the *Electrolytic* room adjoin the laboratory on the south wall. The electrolytic room contains desks for electrolytic determinations with six working spaces, each of which is furnished with a separate resistance, a voltmeter and a milli-am-meter. In this room is the Glass-Blower's table.

The *Laboratory for Advanced Quantitative Analysis* has working facilities for eight students. But there is a laboratory for special work in which synthetic work and research work can be carried on by a few students. This laboratory is located alongside the professor's office on the main floor.

The class instruction is given in a spacious lecture room, which is located at the east end of the second floor. This room seats 132 students in nine rows, each row being three inches higher than the preceding one. The lecture desk is furnished in the modern manner, with the electric current, and switch-board arrangements, also with water, gas and compressed air. The desk is unobstructed by any hood. Experiments generating noxious gases are carried on in a hood which stands in the adjoining preparation room behind a movable glass panel. When the latter is raised the apparatus under the hood will be visible from all parts of the room. Provision is made for the display of charts and diagrams in front of and above the black-boards behind the lecture table.

The supply clerk's office and store-rooms are located in the basement, but are connected with the main floor by means of a dumb waiter.

F 1. General Experimental Chemistry.

Professor KOENIG and Mr. WILSON.

Twelve hours a week, twenty-eight weeks, fall, winter and first half of spring terms; one recitation, three lectures, and six hours of laboratory work each week; to count as eleven-tenths of a credit.

The instruction in this subject covers the following ground:

First. Experiments with the common metals, their action when heated in air, and when heated in the absence of air; discovery of the composite nature of air; a life sustaining part (ozone); a life destroying part (azote). Specific gravity of azote by direct weight and of ozone by calculation. The increase in weight of metals when heated in air, discovery of ozonites (oxides.) Ratio of increase. Burning of sulphur in air, discovery of a gaseous sulphur ozonite possessing an acid taste; change of the name ozone into oxygen. Restoration of the original metals from the oxyds by the action of charcoal; hence the notion of elements or simple bodies. Action of the common metals at a red heat upon steam, the forming of bodies similar to the oxides and of an inflammable gas; discovery of hydrogen and its properties. Proving the identity of water oxides with air oxides, hence the conclusion that water is a combination of oxygen with hydrogen.

Second. (1) The study of copperas or vitriol. Under the action of heat it yields an oily liquid—the oil of vitriol. Correlation of this body with sulphur oxide. With the oil of vitriol the student has gained now a powerful reagent, but he does not know, and should not be told at this stage of his development that this oil of vitriol is $H^2 SO^4$. The body is for his purposes simply oil of vitriol, for which the symbol Ov may stand.

(2) Study of potash, soda ash, limestone. Their action with heat, with heat and charcoal, with oil of vitriol. Their action upon each other; of burnt lime upon potash. Discovery of potassium, sodium, calcium, of caustic soda, caustic potash, and of a non-life-sustaining, heavy, slightly sour gas, lime gas (not CO_2). Alkaline reaction, acid reaction; the notion of hydroxides, of acid hydroxides and of basic hydroxides.

G 5. Metallurgical Organization.

Professor AUSTIN.

Nine hours a week, twelve weeks, fall term. To count as three-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy).

The course of instruction will consist of recitations and lectures on the principles of organization of corporations and on the duties of the officers and accounting force of a metallurgical establishment.

The subject is divided as follows:

Organization of companies and of working forces. Management, superintendence, skilled and unskilled labor. Constitution of capital; stocks, bonds, dividends and profits.

Conyngton on Corporation Management will be used as a text book, and references will be looked up and notes made by the student.

G 6. Metallurgical Accounting.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by, or accompanied with G 2 (Metallurgy).

The course of instruction includes the accounting and book-keeping necessary in a metallurgical works. It takes up the costs and expenses of operation, of ore supply, fuel, fluxes, by-products and markets. It considers sinking funds, insurance, deterioration and repairs, balance sheets and annual statements.

G 7. Practice Work in Metallurgy.

Professor AUSTIN and Mr. COPELAND.

Forty-five hours a week, three weeks, first half of summer term. Furnace work. To count as five-tenths of a credit. To be preceded by G 3 (Metallurgical Laboratory Practice).

The blast furnace-practice will include the receiving, sampling and bedding of the ores, assaying and calculating the ores, fluxes and fuel. Starting and operating the blast-furnace. Study of reverberatory-furnace operation. Cleaning up, sampling and analyzing the products and determining the metallurgical losses. Besides the student will be required to keep a set of accounts of all the operations, to determine the profits and losses of the smelting operations and the costs of smelting the various ores.

M. MECHANICAL ENGINEERING.

Professor Hood, Assistant Professor Christensen, Messrs. Anderson, Johnson, Richards, Freeman and Hill.

The successful and economical operation of any mine depends so largely upon the judicious selection, proper design and skilful operation of the power plant and general machinery, that the College offers a course in mechanical engineering specially designed to prepare the student to take up such work.

The aim has been to so use those Mechanical Engineering subjects of special prominence in mining work as to give the student thorough training, and to indicate the methods of study and observation to be followed after graduation, should he decide to take up any branch of Mechanical Engineering as his specialty.

Throughout the whole course the attempt is made to present clearly the theory underlying each part of the work, and to fix and illustrate the theory by practical exercises in the shop, laboratory, draughting room, or reference to neighboring mine equipments.

Mechanical Engineering Building.

The workshop, mechanical laboratories, electrical engineering laboratories, and the draughting room, are located in the Mechanical Engineering Building.

Courses in the following subjects are offered:

M 1. Properties of Materials of Engineering.

Assistant Professor Christensen.

General mechanical properties of metals; cast and wrought iron, steel, copper, brass and bronzes; lime, cement, concrete and brick; paints; timber and cordage; etc.

Three times a week, twenty-three weeks, fall and winter terms. To count as seven-tenths of a credit. To be preceded by B 1 (Physics) and F 1 (General Chemistry), and preceded by, or accompanied with B 4 (Physics).

The course includes a discussion of methods of manufacture of the more important materials (except such information as comes within the province of the course in Metallurgy); forms in which these materials appear in the market; their adaptation to the purposes of the engineer; methods of preserving materials from corro-

sion and decay, etc. Johnson's The Materials of Construction. The course is supplemented with practical work in testing, for details of which see M 6 (Testing Materials of Engineering).

M 2. Shop Practice.

Mr. Richards, Mr. Johnson and Mr. Uren.

Shop practice is of value in giving intimate knowledge of the properties of materials, of the uses of machines for working them, and of the difficulties of attaining accuracy. Judgment in the use and selection of machinery is best trained in the shop. The skill acquired in the use of machines and tools may be of direct value, and is always of indirect value in giving familiarity and sympathy with such work. The course covers nine hours a day, except Saturday, for twelve weeks, summer term, and includes practice in wood and metal work. To count as two credits.

The practical instruction given is largely personal and each is advanced as rapidly as his proficiency will warrant. Recitations concerning the work are required. In the machine shop, practice is offered in bench and vise work, blacksmithing and with all of the usual machine tools. In the pattern shop, patterns are made of parts to be later completed in the machine shop. The course includes the use of wood-working bench tools and power machinery.

The shop is run as nearly like a producing shop as possible. Exercises for students are selected from parts of machines in course of actual construction and intended for use about the institution, as, crushing rolls, air compressors, rock drills, machine tools, etc. All work done in the shops is considered as the property of the college. No student is allowed work not assigned to him by the instructor.

Shop Equipment.

In addition to necessary work benches and hand tools, the shop contains—

One 24-inch by 16-foot New Haven Tool Co.'s lathe.
One 16-inch by 6-foot Lodge & Shipley lathe.
Two 14-inch by 5-foot Lodge & Shipley lathes.
Six 14-inch by 6-foot Reed lathes.
One 14-inch by 8-foot Reed lathe.
One 14-inch by 6-foot Lodge & Davis lathe.

One 13-inch by 5-foot Putnam lathe.
One 12-inch by 5-foot Prentis lathe.
One No. 2 Landis Grinder for hardened steel work.
One 24 x 24 x 8′ Whitcomb planer.
One 20 x 20 x 4′ Wm. Sellers & Co. planer.
One 16″ Gould & Eberhardt shaper.
One 10″ Traverse head shaper.
One 34″ Blaisdel drill press.
One 20″ Lodge & Davis drill press.
One sensitive drill.
One twist drill grinder.
One No. 1½ Cincinnati tool room milling machine.
Three emery tool grinders.
One buffing wheel.
One Power hack saw.
One 2-inch pipe and bolt machine.
One Arbor press.
One steam hammer.

The assortment of chucks, taps, drills, reamers and general tools is extensive. For practice in pipe fitting a separate bench has been provided; a complete set of pipe tools, and a supply of pipe and fittings up to two inches inclusive are in stock.

The blacksmith shop occupies a room 26 x 43 and is completely equipped with eight forges and the necessary hand and power tools.

The pattern shop contains ten wood lathes, a pattern maker's lathe to swing five feet, a 33-inch Fay band saw, a Beach jig saw, a 24-inch Fay hand planer and joiner, a 24-inch pony planer, Colburn universal saw bench, emery wheels and grindstones, gouge grinder, steam glue heaters, an extensive assortment of hand tools and appliances, and the necessary work-benches and vises.

Each student, in each shop, has a separate work bench, set of hand tools, and locker, for which he is held responsible. Any damage to tools, or other part of the equipment, beyond wear and tear by legitimate use, is charged to the student accountable for it.

Each shop has a good tool room, in which the check system of accounting for tools is used.

Power for the shops is furnished by motors.

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One 14-inch by 8-foot Reed lathe.
One 14-inch by 6-foot Lodge & Davis lathe.

One 13-inch by 5-foot Putnam lathe.
One 12-inch by 5-foot Prentis lathe.
One No. 2 Landis Grinder for hardened steel work.
One 24 x 24 x 8′ Whitcomb planer.
One 20 x 20 x 4′ Wm. Sellers & Co. planer.
One 16″ Gould & Eberhardt shaper.
One 10″ Traverse head shaper.
One 34″ Blaisdel drill press.
One 20″ Lodge & Davis drill press.
One sensitive drill.
One twist drill grinder.
One No. 1½ Cincinnati tool room milling machine.
Three emery tool grinders.
One buffing wheel.
One Power hack saw.
One 2-inch pipe and bolt machine.
One Arbor press.
One steam hammer.

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One No. 2 Landis Grinder for hardened steel work.
One 24 x 24 x 8′ Whitcomb planer.
One 20 x 20 x 4′ Wm. Sellers & Co. planer.
One 16″ Gould & Eberhardt shaper.
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One 34″ Blaisdel drill press.
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Three emery tool grinders.
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One 2-inch pipe and bolt machine.
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Each shop has a good tool room, in which the check system of accounting for tools is used.

Power for the shops is furnished by motors.

Special Students.

Those who desire to take shop work only, and devote all their time to it, are admitted as special students on the following conditions: No student shall be less than 17 years of age. Students between the age of 17 and 20 must present evidence of having spent at least two years in some reputable high school or academy. Persons 20 years of age or over may be admitted as special students, without having attended a high school, provided they give evidence of being able to follow the work with profit. Some knowledge of drawing, or practice in reading drawings, is essential.

Under some conditions the machine shop is open to students at other times than during the summer term.

M 3. Design of Structural Joints.

Assistant Professor CHRISTENSEN.

Fifteen hours a week, eleven weeks, winter term. To count as six-tenths of a credit. To be preceded by, or accompanied with, M 4 (Mechanics of Materials). A study of the design of structural joints in wood and metal based upon the fundamental principles of stress and strength of materials. Dimensioned sketches or drawings showing complete working details will be required in the solution of each problem.

M 4. Mechanics of Materials.

Assistant Professor CHRISTENSEN.

Three times a week, twenty-three weeks, fall and winter terms. To count as seven-tenths of a credit. To be preceded by M 1 (Properties of Materials), and preceded by, or accompanied with, C 2 (Analytic Mechanics).

Applications of the principles of statics to rigid bodies; elasticity and resistance of materials; cantilevers; simple, restrained and continuous beams; forms of uniform strength, riveting, torsion of shafts, combined stresses; resiliance; apparent and true stresses; computation of proper sizes and proportions of beams, columns, shafts, flat plates, etc. Merriman's Mechanics of Materials, and Cambria Steel.

M 5. Mechanical Engineering I.

Professor Hood.

Three times a week, twelve weeks, fall term. To count as four-tenths of a credit. A non-mathematical treatment of the steam engine, boiler, and attendant details, being an introduction to the Mechanical Engineering of Power Plants. Text book, Hutton's The Mechanical Engineering of Power Plants.

M 6. Testing Materials of Engineering.

Assistant Professor Christensen.

Tensile, compressive, transverse and torsional tests of metals and timber. Tensile tests of cordage, and iron and steel wire rope. Transverse, compressive, and absorption tests of stone and brick. Tensile, comprehensive, cross-breaking, and specific gravity tests of cement, also tests for fineness, time of setting, and constancy of volume. Tests of lubricating oils, including density, viscosity, fire test, cold test, wearing qualities and co-efficient of friction under various speeds and loads on journals. *Forty-five hours a week,* last six weeks of summer term. To count as one credit. To be preceded by subject M 4 (Mechanics of Materials). Text books used, Johnson's Materials of Construction and Spalding's Hydraulic Cement.

Laboratory for Testing Materials.—The equipment of this laboratory is as follows: One 100,000 ℔. Riehle machine, fitted for making tensile, compressive, cross breaking, and shearing tests. Several appliances have also been provided to enable this machine to make shearing tests on wood, and transverse tests on specimens up to 9 feet in length; an Olsen 20,000 ℔. machine for the same service on smaller pieces; an Olsen No. 1 power torsional testing machine, a Thurston autographic torsional testing machine, an Ashcroft oil tester, 2,000 ℔. Olsen cement testing machine, with tools for tensile, compressive and transverse tests, briquette forming and cement mixing machines, and other measuring and testing devices.

Those having materials to be tested may make arrangements with the professor in charge for tests.

M 9. Mechanical Engineering: Laboratory Practice.

Professor HOOD and Assistant Professor CHRISTENSEN.

Experimental work in the Mechanical Laboratory; determination of heating value of fuels; quality of steam; use of steam engine indicator; Prony brake, and other dynamometers; standardizing of indicators, steam gauges, etc.; valve setting, complete tests of engines, boilers and pumps, Carpenter's Experimental Engineering, Kent's Mechanical Engineer's Pocket Book. *Forty-five hours a week,* first six weeks of summer term. To count as one credit. Must be preceded by M 13 (Mechanical Engineering IV). This course is intended to give the student ample opportunity to verify practically the principles laid down in the preceding courses. Each student will be required to set up his own apparatus, and in many cases to design and build appliances for any special work on hand.

Equipment.

The power plant contains two Parker Steam Generators of 100 H. P. each, one 58 H. P. Stirling water-tube boiler, induced draft system, one 8 x 24 Reynolds Corliss engine, one 8 x 12 Buckeye engine in the dynamo room, a 13 x 12 Chandler & Taylor simple engine direct connected to a 3-phase generator, a 9 x 9 N. Y. safety vertical slide valve engine in the Ore-Dressing building, a 5 x 5 horizontal slide valve engine. Of the minor apparatus there is now in stock one Tabor indicator, and six Crosby indicators with electrical attachment, two American Thompson indicators, one Hine & Robertson indicator, one Collins continuous indicator, eight polar planimeters, ten of Green's standard thermometers for calorimetric work, calorimeters of the following kinds—barrel, continuous, superheating, throttling, and separator; Carpenter Coal Calorimeter, and Parr Calorimeter—one 15 H. P. Flather hydraulic dynamometer arranged for either transmission or absorption, Heath's stop-watch speed counter. Tabor speed counter, Schaeffer & Budenburg tachometer, pantographs, Hine & Robertson reducing motion, draught gauges. Ashcroft boiler test pump and gauge; gauges for use with water or steam, and gauge tester of the Ashcroft pattern, Ashcroft pyrometer, Bristol recording gauge, one Hancock ejector, a number of working injectors, with cut models of same, Buffalo scales of several patterns, Burnham, Worthington and Davidson pumps,

The use of drawing instruments, the graphical solution of geometrical problems. Descriptive Geometry. Projection on right and oblique planes, intersection of lines, surfaces and solids, plans, elevations and sections, isometric projection. Anthony's Elements of Mechanical Drawing. Reinhardt's Lettering.

The instruction in the art of drawing is designed to give prominence to such branches of the subject as are of most value to the practicing engineer. It is required that the instruments used shall be of the best and for the convenience of students a suitable grade is offered for sale at the College. Instruments required are:

One 5½-inch compass.
One 3¼-inch bow spacer.
One 3¼-inch bow pencil.
One 3¼-inch bow pen.
One 5-inch ruling pen.
One 30°—60° triangle.
One 45° triangle.
One curve.
One 30-inch Tee square.
Two bottles of ink.
Eight thumb tacks.
Three rubbers.
Two pencils.
Twelve pens.
One penholder.
Penwipers.
Chamois.
Cloth board covers.
One file pencil-sharpener.
One 15-inch adjustable curve.
One 12-inch white-edged scale.

Draughting Room and Equipment.

The Draughting Room is 25 x 97 feet, with a 28 x 34-foot annex, containing instructors' offices, blue-print room, lavatory, etc. The room is on the north side of the building, thereby insuring freedom from shadows at any part of the day. It is provided with electric lights so arranged as to permit night work with the minimum of discomfort. The drawing tables provide each student with private

lockers for his materials and a rack for board and T-square. There are sun and electric blue-printing equipments, etc. There are also cut models of pumps, injectors, valve gears, drawing of machinery, etc., used as illustrative material.

M 16. Machine Drawing.

Messrs. JOHNSON, FREEMAN and HILL.

Fifteen hours a week, eleven weeks, winter term. To count as six-tenths of a credit. To be preceded by M 15 (Mechanical Drawing).

Making of complete working drawings of various details of machine construction from drawings, sketches of models. Tracing and blue-printing. Anthony's Machine Drawing.

N. ELECTRICAL ENGINEERING.

Professor Hood and Mr. Anderson.

The rapid development of electrical methods as applied to a wide field of mining practice in lighting, power transmission, and metallurgical manipulation, makes a broad knowledge of the principles of electricity necessary to the well-equipped mining engineer. A study of electrical engineering, both fixes these principles and gives some familiarity with current engineering practice. Such subjects as are of special prominence in mining are naturally accentuated here. The courses outlined are as follows:

N 1. Electrical Engineering.

Mr. ANDERSON.

An introductory course presenting dynamo and motor construction, transformers, secondary batteries, lamps, etc., and questions concerning their selection, installation, care and wiring for light and power. Electrical Engineering by Rosenberg, Gee and Kinsbrunner, and Badt's Incandescent Wiring Hand-Book. *Three times a week,* twenty-three weeks, fall and winter terms. To count as seven-tenths of a credit. To be preceded by M 11 (Mechanical Engineering II), and preceded by, or accompanied with B 3 (Electrical Measurements).

N 3. Electrical Engineering: Laboratory Practice.

Professor Hood and Mr. Anderson.

Experimental work in the Electrical Laboratory, having for its object the familiarizing of the student with the general construction, running and testing of the common forms of electrical apparatus used in lighting and power transmission. The laboratory affords practice with direct, alternating and polyphase currents, incandescent and arc lighting, and motors on constant potential, constant current and polyphase circuits.

The equipment includes two direct current dynamos with four motors. A 33 K. W., 1,000 Volt, alternating current machine. One 70 K .W. and one 15 K. W. three-phase generator with several motors. Two arc light machines, one constant current motor, a 60 Cell Storage Battery, all with suitable switch board, instruments, transformers and laboratory measuring instruments.

Forty-five hours a week, second six weeks of summer term. To count as one credit. To be preceded by N 1 (Electrical Engineering).

Q. CIVIL ENGINEERING.

Professor Sperr, and Messrs. Houle, Schubert, Langworthy, Botsford and ——.

Q 1. Surveying (Field Work).

Professor Sperr, and Messrs. Houle, Schubert, Langworthy. and ——.

Fifty hours a week, twelve weeks, summer term. Beginning about the first of June each year. To count as two and two-tenths credits. To be preceded by A 3 (Spherical Trigonometry) and Q 4 (Topographical Drawing), except that persons of experience, who wish to attend this course only, are required to prepare themselves upon the subjects of Plane Trigonometry, Logarithms and Mensuration; and provide themselves with the drawing instruments and materials required for Drawing under the Civil Engineering depart-

ment. All persons who desire to attend are requested to send in their names early to Professor Sperr, or to the President of the College, in order that proper provision may be made for them.

It is believed that the principles of surveying can be more easily and more thoroughly learned if the study of the text book and the use of the instruments go hand in hand. The lessons in the text books are assigned ahead of the time when the work is taken up in the field, in order that the student may first study the subject and then work out the problems which arise from his own use of the instruments in the field.

The aim in laying out the field work is to make it of a commercial character, to be executed in a commercial and practical manner.

An outline of the work is as follows:

I. Preliminary Surveying.

1. Pacing practice.
2. Preliminary location of mining claims and filing of notice of location.
3. Adjustment of hand level. Short line of levels with the hand level.
4. Topographical survey of mining claim by pacing and hand level.
5. Ranging practice with pickets and chain.

II. Land Surveying.

1. Adjustment of compass.
2. Subdivision of a section of land according to United States Land Office regulations, location of lost corners, etc.
3. Farm survey with transit and chain. Computation of acreage.
4. City survey of portion of Houghton, location of street, alley, and lot lines by transit and steel tape. Platting an addition.
5. Survey of mining claim with solar instrument, official survey for United States patent. Includes adjustment of solar attachments.

III. Geodetic Surveying.

1. Measurement of base line for triangulation system covering an area of about ten square miles on the opposite shores of Portage Lake. Standardizing tapes.

2. Erection of signals and stations for triangulation observation.
3. Reading angles with the transit.
4. Computations for and adjustment of the triangulation system.
5. Adjustment of Engineers' level.
6. Determination of elevations of bench marks and triangulation points by leveling from Portage Lake.
7. Observation on Polaris with transit for determination of true azimuth.

IV. Topographical Surveying.

1. Adjustment of transit.
2. Repetition traverse with transit and steel tape.
3. Azimuth traverse with transit and stadia.
4. Adjustment of plane table instrument.
5. Topographical survey of certain area with plane table.
6. Topographical survey of certain area with transit and stadia.
7. Tying up of topographical survey to triangulation system.

V. Railroad Surveying.

1. Reconnoissance with clinometer and pocket compass.
2. Preliminary survey with transit, chain, and Engineer's level. Topography by pacing and hand level.
3. Permanent location with transit, steel tape, and Engineer's level.
4. Computation of simple and compound curves. Setting curve and line stakes with transit and steel tape.
5. Profile leveling. Plotting on profile sheet and establishment of grade.
6. Cross-sectioning.
7. Computation of excavations and embankments.
8. Computing and laying in turnouts, frogs, switches, and Y junction curves.

Maps are required to be made of the mining claim pacing survey, the mining claim official survey, the azimuth and repetition traverse surveys, the farm survey, the stadia survey, the city survey, and the railroad survey.

The class is divided into squads, with just a sufficient number in the squad to do the required work. By rotation each member of

ment. All persons who desire to attend are requested to send in their names early to Professor Sperr, or to the President of the College, in order that proper provision may be made for them.

It is believed that the principles of surveying can be more easily and more thoroughly learned if the study of the text book and the use of the instruments go hand in hand. The lessons in the text books are assigned ahead of the time when the work is taken up in the field, in order that the student may first study the subject and then work out the problems which arise from his own use of the instruments in the field.

The aim in laying out the field work is to make it of a commercial character, to be executed in a commercial and practical manner.

An outline of the work is as follows:

I. Preliminary Surveying.

1. Pacing practice.
2. Preliminary location of mining claims and filing of notice of location.
3. Adjustment of hand level. Short line of levels with the hand level.
4. Topographical survey of mining claim by pacing and hand level.
5. Ranging practice with pickets and chain.

II. Land Surveying.

1. Adjustment of compass.
2. Subdivision of a section of land according to United States Land Office regulations, location of lost corners, etc.
3. Farm survey with transit and chain. Computation of acreage.
4. City survey of portion of Houghton, location of street, alley, and lot lines by transit and steel tape. Platting an addition.
5. Survey of mining claim with solar instrument, official survey for United States patent. Includes adjustment of solar attachments.

III. Geodetic Surveying.

1. Measurement of base line for triangulation system covering an area of about ten square miles on the opposite shores of Portage Lake. Standardizing tapes.

2. Erection of signals and stations for triangulation observation.
3. Reading angles with the transit.
4. Computations for and adjustment of the triangulation system.
5. Adjustment of Engineers' level.
6. Determination of elevations of bench marks and triangulation points by leveling from Portage Lake.
7. Observation on Polaris with transit for determination of true azimuth.

IV. Topographical Surveying.

1. Adjustment of transit.
2. Repetition traverse with transit and steel tape.
3. Azimuth traverse with transit and stadia.
4. Adjustment of plane table instrument.
5. Topographical survey of certain area with plane table.
6. Topographical survey of certain area with transit and stadia.
7. Tying up of topographical survey to triangulation system.

V. Railroad Surveying.

1. Reconnoissance with clinometer and pocket compass.
2. Preliminary survey with transit, chain, and Engineer's level. Topography by pacing and hand level.
3. Permanent location with transit, steel tape, and Engineer's level.
4. Computation of simple and compound curves. Setting curve and line stakes with transit and steel tape.
5. Profile leveling. Plotting on profile sheet and establishment of grade.
6. Cross-sectioning.
7. Computation of excavations and embankments.
8. Computing and laying in turnouts, frogs, switches, and Y junction curves.

Maps are required to be made of the mining claim pacing survey, the mining claim official survey, the azimuth and repetition traverse surveys, the farm survey, the stadia survey, the city survey, and the railroad survey.

The class is divided into squads, with just a sufficient number in the squad to do the required work. By rotation each member of

the class is required to do every different kind of work with every different instrument used, make a full set of notes of the work done by his squad, and from these notes make the maps in the drawing room.

The equipment for instruction comprises the following set of instruments:

Five Buff & Berger transits.
Six C. L. Berger & Sons transits.
Three Heller & Brightly transits.
Two Fauth & Co. transits.
One Brandis transit.
Seven W. & L. E. Gurley transits.
One Mahn & Co. transit.
Two Buff & Buff transits.
Ten W. & L. E. Gurley Engineer's levels.
Three Heller & Brightly Engineer's levels.
One Buff & Berger Engineer's levels.
Two C. L. Berger & Sons Engineer's levels.
One Buff & Berger plane table.
One C. L. Berger & Sons plane table.
Four W. & L. E. Gurley plane tables.
One Brandis plane table.
Five W. & L. E. Gurley Burt solar compasses.
Seven W. & L. E. Gurley Surveyor's Compasses.
Five Brunton pocket mine transits.
Ten water levels.
Fifty-eight Locke hand levels.

In addition to these more expensive instruments the College owns the necessary number of chains, steel tapes, poles, rods, etc.

The furnishing of the Surveying apparatus by the College is a heavy expense to the institution, and while losses due to ordinary and legitimate wear and tear of the instruments are borne by the College, any injuries due to carelessness on the part of the student must be made good by him.

Every student is required to provide himself with a steel pocket tape graduated to feet and tenths, and not less than 25 feet long, a pocket compass, a reading lens, a wood ax, a timber pencil, a field book, and drawing instruments as in Q 4 (Topographical Drawing).

Text books: Theory and Practice of Surveying, Johnson; Field Engineering, Searle.

Q 2. Hydraulics.

Mr. SCHUBERT.

Three times a week, sixteen weeks, winter term and first half of spring term. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining), and preceded by, or accompanied with A 5 (Calculus).

One trip will be made to some hydraulic plant.

Recitations and problems will be given on the following:

1. Hydrostatics.
2. Theoretical hydraulics.
3. Flow through orifices.
4. Flow over weirs.
5. Flow through tubes.
6. Flow in pipes.
7. Flow in conduits and canals.
8. Flow in rivers.
9. Measurement of water power.
10. Dynamic pressure of flowing water.
11. Water wheels.
12. Turbines.

Text Book: Treatise on Hydraulics, Merriman.

Q 3. Hydraulics.

Professor SPERR and Mr. SCHUBERT.

Two hours a week in lecture room and seven hours in laboratory, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by Q 2 (Hydraulics) and M 5 (Mechanical Engineering I).

The Hydraulic Laboratory is provided with two main reservoirs, —a steel supply reservoir of 18,000 gallons capacity in the tower of the building, and a reservoir below in the form of a canal of 25,000 gallons capacity, giving a head of about 90 feet. The discharge from the supply reservoir is through a 10-inch stand pipe, which may be drawn from at the different floors in the tower by nine 10-inch Fairbanks gate valves. Galvanized iron conduits pass the entire length of the tower and are so arranged as to conduct the flow into the reservoir below or into large weighing tanks at will.

The main part of the laboratory is sixteen feet in the clear, with balcony around for accommodation of light appliances. Also passing around this part are mains as follows: A 6-inch water supply, a 6-inch pump discharge (into supply reservoir or weighing tanks), a 2½-inch steam supply, a 3-inch steam exhaust (into atmosphere or surface condenser), and along the north balcony, a 6 x 12-inch conduit to a pair of hanging tank scales. Steam and electricity are furnished by the central Power Plant operated by the Mechanical Department.

A complete electrical signal and telephone system is in operation, consisting of fixed and portable sets so arranged that communication may be had between any two or more points in the Main Laboratory or Tower.

The following apparatus is now available for experimental work:

One 5½ x 3½ x 5 Snow duplex steam pump.

One 8 x 8½ x 12 Snow duplex steam pump.

One 6 x 12 Deane triplex electric pump with 7 H. P. induction motor and Reeves speed regulator.

One 12-inch Morris centrifugal pump.

One Evans hydraulic gravel elevator, with sluices, undercurrent and riffles.

One Evans hydraulic giant.

One 20-inch Pelton water motor.

One 15-inch Tuthill water motor.

One Doble water motor with glass covers.

One 8-inch Leffel turbine.

One Worthington water meter.

One Price acoustic current meter.

One orifice tank for low heads.

Two Buffalo platform tank scales, each 20,000 lbs. capacity.

Two Buffalo hanging tank scales, each 3,560 lbs. capacity.

Two Buffalo platform scales, each 2,560 lbs. capacity.

One Buffalo laboratory scales of 400 lbs. capacity, and sensitive to 1/100 of a pound.

One 5 H. P. electric induction motor for driving line shaft.

Six valve orifice plates of special design, with orifices interchangeable from the outside and without loss of water.

In the laboratory are also numerous orifices and weirs of various shapes and sizes, steam, water, mercury, and hook guages; speed

indicators, steam indicators, and other apparatus necessary for determining the efficiency and coefficients of the various hydraulic appliances used in connection with mining operations. One or more trips may be made to hydraulic works in the vicinity.

Text Books:

Treatise on Hydraulics, Merriman.
Notes and Library References.

Q 4. Topographical Drawing.

Mr. Botsford.

Fifteen hours a week, five weeks, last five weeks of spring term. To count as three-tenths of a credit. To be preceded by M 15 (Mechanical Drawing). This subject is required for the summer course in Surveying (Q 1). The course is given by lectures and individual instruction in the Drawing Room on the following:

I. Making Titles, Scales, Borders, etc.
II. Traversing.
III. Plotting.
 1. By Protraction.
 2. By Rectangular Co-ordinates.
IV. Computing.
 1. Areas.
 2. Volumes.
V. Topography.
 1. Topographical Signs.
 2. Topographical Maps.

Instruments Required.

One 5-inch right line pen.
One swivel curve pen.
One 5½-inch compass (pivot joint) with hair spring, pen, pencil, points and extension bar.
One 3¼-inch bow pen.
One 3¼-inch bow pencil.
One 3¼-inch bow dividers.
One protractor.
One 12-inch triangular decimal scale.

One 10-inch 30 x 60-degree amber triangle.
One 9-inch 45-degree amber triangle.
One-half dozen thumb tacks.
One bottle Higgins' black *water-proof* drawing ink.
One bottle Higgins' carmine drawing ink.
One rubber pencil eraser.
One ink eraser.
One sponge rubber.
One 6H. pencil.
One piece chamois skin, about 12 x 8 inches.
One-half pan each, moist colors, as follows: Prussian blue, burnt sienna.
Two No. 1 Spencerian pens, with holder.
Two mapping or crow quill pens, with holder.
Two ball pointed pens.

All instruments must be of first-class quality. Students will not be allowed to work with inferior instruments. Articles in the above list may be purchased by students at the College.

Text Books:

A System of Free-hand Lettering, Reinhardt.
Theory and Practice of Surveying, Johnson.

Q 5. Surveying (Office Work).

Mr. Houle.

Ten hours a week for eleven weeks, winter term. To count as four-tenths of a credit. To be preceded by Q 1 (Surveying).

In this course the objects and purposes of the field and railroad surveying are more fully developed,—new points are taken up in the text by lecture and recitation, and practice is given in the drawing room involving methods and instruments used in the surveyor's office.

Text Books:

Notes and Library References.
The Theory and Practice of Surveying, Johnson.

Q 6. Graphical Statics.

Messrs. SCHUBERT and LANGWORTHY.

Twelve hours a week (one lecture, two recitations and nine hours in drawing room), twelve weeks, fall term. To count as five-tenths of a credit. To be preceded by B 1 (Physics), and M 15 (Mechanical Drawing).

This subject is designed to teach the theory of the graphical analysis of stresses in structures, under the action of steady and moving loads, and the pressure of the winds. For example, the solution of a certain class of roof trusses is taken up in the lecture. The student is assigned a number of problems on the different types of trusses in this class, to be solved in the drawing room by aid of the text book and such individual instruction as may be necessary. For this problem he would be required to report the nature and value of the stress in each member of the truss under the various loads specified, each student being given different conditions and data.

Text Book:

The Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures, Ketchum.

Q 7. Engineering Design and Construction.

Professor SPERR and Mr. SCHUBERT.

Twelve hours a week, sixteen weeks, winter term and first half of spring term. To count as seven-tenths of a credit. To be preceded by M 15 (Mechanical Drawing), Q 6 (Graphical Statics), and preceded by, or accompanied with R 4 (Mining Engineering), and M 4 (Mechanics of Materials).

The work in designing is applied to the head-frames, rock houses, engine and boiler houses, bridges, trestles, etc., of the mining plants considered under R 4 (Mining Engineering).

A general outline of the work is as follows:

1. The general requirement of the structure.
2. Drawing the general plans.
3. The materials best adapted to the various purposes.
4. Strength of materials.
5. Methods of construction.

6. Making detailed drawings, bills of materials, and estimate of costs.
7. Synopsis of the law of contracts.
8. Drawing up specifications.
9. Letting contracts.
10. Superintending the construction.

R. MINING ENGINEERING.

Professor Sperr, and Messrs. Houle, Schubert, ———, ———, and ———.

Mining engineering as here used, signifies carrying through a mining enterprise. Intelligently conducted mining operations employ the principles of mathematics, physics and mechanics; the sciences of geology, mineralogy, chemistry and metallurgy; and the arts of civil, mechanical and electrical engineering; and demand capacity for organization and business management.

These principles, sciences, etc., are taught by specialists and experts in different departments; and their special application to the business of mining is taught under the head of Mining Engineering.

The leading sub-divisions are Mining, Surveying, Engineering and Management.

A Thompson reflectoscope has been added to the equipment for instruction during the past year.

R 1. Principles of Mining.

Professor Sperr and Mr. Houle.

Eleven hours a week for sixteen weeks, winter term and first half of spring term. To count as six-tenths of a credit. Must be preceded by, or accompanied with Y 1 (Principles of Geology).

The scheme of giving the instruction is as follows:

I. Lectures once a week, are based upon the following outline:
   1. Prospecting: aids, methods, outfit, territory and qualifications.
   2. Breaking ground: hand tools, machinery and blasting operations.
   3. Supporting excavations: rock pillars, timber, masonry and metallic supports.

[redacted]

4. Conveyance of mineral: haulage by men, animals, locomotives, electric motors, single rope, tail rope, endless rope and endless chain; transport by mills, packs, pipes, launders and boats; hoisting receptacles, ropes, motors, signals and safety appliances; pumping oils, mineral solutions and alluvia. Lowering timber and lowering and raising workmen.
5. Drainage: surface—ground water, streams, swamps and lakes; mine—ground water, old workings and flooded mines.
6. Ventilation: pure air constituents and requirements; mine air vitiation and purification; accidents from impure air and the means and methods of prevention; rescue and resuscitation.
7. Illumination: candles, torches and lamps classified as oil, gasoline, magnesium, acetylene, electric and safety.

II. Lessons are regularly assigned, running parallel with the subjects of lectures.

III. Excursions are made on Saturdays into the copper mines where the students become familiar with the practical application of the principles discussed in the lectures and laid down in the text book.

IV. One recitation a week upon the lectures and the excursions.

V. Two recitations a week upon the text book.

Text Book:

Elementary Mining and Quarrying, Foster.

R 2. Mine Surveying and Mining (Classroom Work).

Professor Sperr and Mr. Houle.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit. To be preceded by Q 1 (Surveying) and R 1 (Principles of Mining).

OUTLINE OF THE SUBJECT.

I. MINE SURVEYING.

1. Definition.
2. Objects and Purposes.
3. Maps Required.

4. Instruments Used.
5. Adjustment of the Transit.
   a. Adjustment of the Side Telescope.
   b. Adjustment of the Top Telescope.
6. The Reference Line.
7. Connection of the surface with the underground survey through an inclined shaft or slope.
   a. Form of Notes.
   b. Problems.
8. Connection of the surface with the underground survey through a vertical shaft.
   a. With the Transit.
   b. By means of Plumb Lines.
9. Methods of Traversing Underground.
10. Surveying of Coal Mines.
   a. Putting up Sights.
   b. Taking up Rooms, etc.
11. Determination of Strike and Dip.

II. MINING.

1. Coal Mining.
   a. Prospecting the Property.
   b. Locating the Shaft, Slope or Drift.
   c. Laying out the Mine.
2. Iron Ore Mining.
   a. Prospecting the Deposit.
   b. Locating the Shaft.
   c. Laying out the Mine.
3. Mine Timbering.
   a. Drifts and Levels.
   b. Stopes.
   c. Raises and Chutes.

The instruction is given from private notes and from references to professional papers to be found in the College library.

R 3. Mine Surveying and Mining (Field Work).

Professor SPERR and Messrs. HOULE, SCHUBERT and ———.

Fifty-four hours a week, five weeks, last half of spring term. To count as one credit. To be preceded by R 2 (Mine Surveying and Mining), except for students who enter for this subject only,

who are required to be prepared in Algebra, Trigonometry, and in the use of the transit and level.

The first two weeks are devoted to surveying and mapping a mine or some portion thereof, in some one of the iron mining districts of Northern Michigan. The last three weeks are devoted to the examination of mining methods in the iron ore mines. Sketches are made of the plans of the mines to show methods of laying out; of cross-sections to show methods of stoping; of timber structures to show methods of framing; of the timbering set up in drifts and stopes; of the tramming, hoisting and general handling arrangements; of ore-chutes, ore pockets, etc.

R 4. Mining Engineering.

Professor Sperr.

Three hourse a week, sixteen weeks, winter term and first half of spring term, and *four hours a week* in the laboratory, five weeks, first half of the spring term. To count as five-tenths of a credit. To be preceded by C 2 (Analytic Mechanics), R 3 (Mine Surveying and Mining) and Q 2 (Hydraulics), and preceded by or accompanied with M 4 (Mechanics of Materials).

The subject is divided as follows:

1. The examination and description of mining properties—expert reports, estimates and recommendations.

2. Laying out and planning the surface arrangements for mining operations—head frames, power plants, ore dressing works, houses, roads, and hydraulic engineering works.

3. Laying out mining operations—winning by open pit, adit, slope, shaft and drill hole; and the exploitation of quarries, placers, and deposits of ore, coal, and mineral fluids.

4. Experimental work with mining machinery in the laboratory.

5. Trip to some mine in the vicinity.

The laboratory equipment consists of 16 mine models, one American 10 H. P. air compressor, one Ingersoll-Sergeant two-stage cross-compound air compressor, one surface condenser, one steam indicator, one Ingersoll-Sergeant rock drill, one Sullivan rock drill, one Sullivan coal digger, one Sullivan diamond prospecting hand drill; six safety lamps, one ventilating fan.

R 5. Mine Management and Accounts.

Professor SPERR and Mr. HOULE.

Nine hours a week, sixteen weeks, winter term and first half of spring term. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining), and R 3 (Mine Surveying and Mining).

The subject comprises the following:

1. Employment, organization and discipline of labor.
2. Purchase and use of supplies.
3. Preparation and sale of mineral.
4. Mine accounts, trial balances, and cost and labor statements.

Given by lectures and a set of notes covering the daily transactions for one month of an extensive mining business.

The proper forms of accounts are designed, and the transactions entered thereon. Then the books are closed and the trial balance, production, labor and cost statements are made out.

R 6. Mechanical Ventilation of Mines.

Professor SPERR.

Two hours a week in lecture room and *seven hours* in laboratory, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The laboratory affords facilities for experimental work with mechanical and hot air ventilators and with various other means for the production of air currents in mines. The ventilating system of the building was put in with this object in view, and it makes a valuable addition to the equipment. A wide field for investigation and research in the laws of ventilation is here presented for advanced students.

The subject is required to be preceded by, or accompanied with M 5 (Mechanical Engineering I) and Q 2 (Hydraulics).

S. ORE DRESSING.

Professor Austin and Mr. Copeland.

S 2. Ore Dressing.

Professor AUSTIN and Mr. COPELAND.

Two hours a week in class room and *three hours* in laboratory, sixteen weeks, winter term and first half of spring term. Also *twelve hours* for excursions to neighboring mills and reports on the same. To count as four-tenths of a credit. To be preceded by B 4 (Physics) W 2 (Mineralogy) and G 1 (Assaying).

The instruction in Ore-Dressing will consist of recitations and laboratory practice, including:

(1) Breaking, crushing and concentrating of ores by stamps, rolls, gravity and steam stamps, and other pulverizers. Laws of crushing.

(2) Concentrating or washing. Washers, screens, screen sizing, classifiers, hand picking, jigging. Sand and slime concentrators.

(3) Milling and amalgamation of gold and silver ores.

(4) Magnetic and ore separations.

(5) Mill processes and management, general ideas on milling.

The students are required to take samples and ascertain by fire or wet assay the degree of efficiency of the operations which they are conducting.

The student in mining engineering will find the ore dressing S 2 to be quite as essential as the metallurgy, since mining engineers, even if not metallurgists, are frequently called on to operate ore dressing or milling plants. The course also develops the methods of sampling, much needed in mining practice.

S 3. Practice Work in Ore-Dressing.

Professor AUSTIN and Mr. COPELAND.

Forty-five hours a week, three weeks, first half of summer term. To count as five-tenths of a credit. To be preceded by S 2 (Ore Dressing) and Q 2 (Hydraulics).

The instruction in Ore-Dressing will consist of recitations, excursions to ore dressing plants and practice at the Ore-Dressing Mill, including:

R 5. Mine Management and Accounts.

Professor SPERR and Mr. HOULE.

Nine hours a week, sixteen weeks, winter term and first half of spring term. To count as five-tenths of a credit. To be preceded by R 1 (Principles of Mining), and R 3 (Mine Surveying and Mining).

The subject comprises the following:

1. Employment, organization and discipline of labor.
2. Purchase and use of supplies.
3. Preparation and sale of mineral.
4. Mine accounts, trial balances, and cost and labor statements.

Given by lectures and a set of notes covering the daily transactions for one month of an extensive mining business.

The proper forms of accounts are designed, and the transactions entered thereon. Then the books are closed and the trial balance, production, labor and cost statements are made out.

R 6. Mechanical Ventilation of Mines.

Professor SPERR.

Two hours a week in lecture room and *seven hours* in laboratory, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

The laboratory affords facilities for experimental work with mechanical and hot air ventilators and with various other means for the production of air currents in mines. The ventilating system of the building was put in with this object in view, and it makes a valuable addition to the equipment. A wide field for investigation and research in the laws of ventilation is here presented for advanced students.

The subject is required to be preceded by, or accompanied with M 5 (Mechanical Engineering I) and Q 2 (Hydraulics).

S. ORE DRESSING.

Professor Austin and Mr. Copeland.

S 2. Ore Dressing.

Professor AUSTIN and Mr. COPELAND.

Two hours a week in class room and *three hours* in laboratory, sixteen weeks, winter term and first half of spring term. Also *twelve hours* for excursions to neighboring mills and reports on the same. To count as four-tenths of a credit. To be preceded by B 4 (Physics) W 2 (Mineralogy) and G 1 (Assaying).

The instruction in Ore-Dressing will consist of recitations and laboratory practice, including:

(1) Breaking, crushing and concentrating of ores by stamps, rolls, gravity and steam stamps, and other pulverizers. Laws of crushing.

(2) Concentrating or washing. Washers, screens, screen sizing, classifiers, hand picking, jigging. Sand and slime concentrators.

(3) Milling and amalgamation of gold and silver ores.

(4) Magnetic and ore separations.

(5) Mill processes and management, general ideas on milling.

The students are required to take samples and ascertain by fire or wet assay the degree of efficiency of the operations which they are conducting.

The student in mining engineering will find the ore dressing S 2 to be quite as essential as the metallurgy, since mining engineers, even if not metallurgists, are frequently called on to operate ore dressing or milling plants. The course also develops the methods of sampling, much needed in mining practice.

S 3. Practice Work in Ore-Dressing.

Professor AUSTIN and Mr. COPELAND.

Forty-five hours a week, three weeks, first half of summer term. To count as five-tenths of a credit. To be preceded by S 2 (Ore Dressing) and Q 2 (Hydraulics).

The instruction in Ore-Dressing will consist of recitations, excursions to ore dressing plants and practice at the Ore-Dressing Mill, including:

(1) Breaking, crushing and concentrating of ores by stamps, rolls, and other pulverizers. Laws of crushing.

(2) Concentrating or washing. Washers, screens, screen sizing, classifiers, hand picking, jigging. Sand and slime concentrators.

(3) Milling and amalgamation of gold and silver ores.

(4) Mill processes and management, general ideas on milling.

The Ore-Dressing Building is a wooden structure 81 by 30 feet. It contains a Blake crusher, a Comet crusher, a pair of crushing rolls, a three stamp battery, a set (three) of trommels, two Hartz jigs, a Spitzkasten, a Frue Vanner, a Rittinger table, a Standard concentrator, a Calumet classifier, a Bridgman and Vezin sampler, and a sample grinder, together with minor machinery.

V. BIOLOGY.

Professor Seaman and Mr. Hitchcock.

V 2. Palaeontology.

Twelve hours a week, twelve weeks, fall term. To count as five-tenths of a credit.

An elementary course only is given in this subject. The object of the course is to train the student in the recognition and determination of a few of the typical fossils from each geological period.

This course must precede Y 2 (Historical Geology).

An elementary knowledge of Zoology will be required of students taking this subject.

The laboratory is supplied with a good collection for students' use.

W. MINERALOGY.

Professor Seaman, and Messrs. Bowen, Newton, Hancock and Hitchcock.

W 1. Crystallography.

Professor SEAMAN, and Messrs. HANCOCK and HITCHCOCK.

Nine hours a week, twelve weeks, fall term. To count as four-tenths of a credit.

The instruction is given by means of lecture notes, and laboratory work, study of models, natural crystals, and cleavage frag-

ments. Hemihedrism, tetartohedrism, hemimorphism and twinning are fully explained in this course.

The laboratory is well supplied with models and natural crystals, necessary for teaching this subject. To be preceded by or accompanied with W 4 (Elementary Mineralogy and Crystallography).

Notes on Crystallography by Professor SEAMAN.

W 2. Mineralogy.

Messrs. HANCOCK, HITCHCOCK and NEWTON.

Twelve hours a week, sixteen weeks, winter and first half of spring terms. To count as seven-tenths of a credit.

Students taking this course are required to provide themselves with A Text Book of Mineralogy, by J. D. Dana, and lecture notes by Professor SEAMAN.

Individual work is one of the features of this course. Each student is required to work out an assigned lot of minerals, and personally recite to an instructor. In these recitations he is required to point out the particular physical characters by which he recognizes his minerals. He must be able to give the chemical composition, orientate the crystal form, and cleavage, and describe the other physical properties that exist. Each student in this course must become familiar with more than two hundred mineral species so that he can either recognize them at sight, or at least after he has applied a few simple field tests, such as hardness, fracture, cleavage, etc.

This subject must be preceded by B 1 (Physics), F 2 (Blowpipe Analysis), W 1 (Crystallography), and Y 1 (Principles of Geology).

W 3. Advanced Mineralogy.

Professor SEAMAN, and Messrs. BOWEN, HANCOCK and HITCHCOCK.

Six hours a week, twenty-three weeks, fall and winter terms. To count as five-tenths of a credit.

This course will be offered only to students who are specializing in Geology, and are taking the advanced Petrography (X 2).

Some of the rare minerals will be studied, as well as some of the less important ores. The products of alteration will be studied more in detail than in the preceding courses. Thermo-electricity, radio-activity and other physical characters not treated in the regu-

lar course, will be discussed and exemplified. About one hundred mineral species not given in the other courses will be studied in some detail.

To be preceded by W 2 (Mineralogy) and accompanied with X 2 (Advanced Petrography).

W 4. Elementary Mineralogy.

Professor Seaman, and Messrs. Hitchcock and Bowen.

Fourteen hours a week, twelve weeks, fall term, and *three hours a week,* sixteen weeks, winter and first half of spring terms. To count as eight-tenths of a credit.

The first four weeks of the fall term will be devoted to crystal study. The last eight weeks will then be given to the study of ore-forming and rock-forming minerals. Only the more common important minerals will be studied in this course. Each student will be required to become familiar with at least fifty mineral species.

In the winter and spring terms the students will be instructed in the classification and determination of rocks, the object of the course being to give the student a sufficient knowledge of rocks and minerals to enable him to comprehend his work in Principles of Geology.

X. PETROGRAPHY.

Mr. Bowen and Mr. Grant.

X 1. Petrography.

Messrs. Bowen and Grant.

Five hours a week for twelve weeks, fall term, and *twelve hours a week* for sixteen weeks, winter term and first half of spring term. To count as eight-tenths of a credit. To be preceded by Y 1 (Principles of Geology), and preceded by, or accompanied with B 5 (Light) and W 4 (Elementary Mineralogy and Crystallography).

The work is divided into two parts: Microscopic Mineralogy and Lithology.

A. Microscopic Mineralogy: Under this head are treated the optical and physical characters of minerals, as revealed by the microscope. Especial attention is directed to those characters by which the minerals may be recognized as rock constituents. The alterations of the minerals are studied with care, owing to the importance of these in the subject of Economic Geology.

B. Lithology: The instruction in this branch of Petrography comprises both the macroscopic and microscopic study of rocks. For this work large and complete collections of rock specimens with thin sections are arranged for the use of the student. The lectures are illustrated by typical hand specimens; also by thin sections projected on a screen by means of a large projecting microscope. Special attention is called to the variations in rocks and to their local modifications due to their special mode of occurrence in the field.

The course is made thorough and practical, every student receiving personal instruction and being required to recite on a large number of hand specimens, and write accurate petrographic descriptions of specimens from various localities.

X 2. Advanced Petrography.

Messrs. Bowen and Grant.

Nine hours a week, sixteen weeks, winter and first half of spring terms. To count as five-tenths of a credit.

This course will consist of a detailed study of the rocks of some assigned locality. Each student is required to make a complete and thorough petrographic report on a group of rocks. Determinations are made of physical, optical and crystallographic constants of rock-making minerals. The relations of the alterations of rocks to ore deposition are taken up more fully than in the course X 1 (Petrography). To be preceded by X 1 (Petrography), and accompanied with W 3 (Mineralogy).

Y. GEOLOGY.

Professor Seaman, and Messrs. Bowen, Hancock, Grant and Hitchcock.

Y 1. Principles of Geology.

Professor Seaman and Messrs. Bowen, Hancock, Grant and Hitchcock.

Two times a week, twelve weeks, fall term, *one time a week,* sixteen weeks, winter and first half of spring terms. To count as four-tenths of a credit. An elementary text-book will be used in

this course. No student will be given credit in this course until he has completed W 4 (Elementary Mineralogy and Crystallography).

Y 2. Historical Geology.

Professor SEAMAN and Mr. HANCOCK.

Four hours a week, sixteen weeks, winter and first half of spring terms. To count as six-tenths of a credit.

The instruction in this study will consist of recitations and laboratory work, and will be given following V 2. The main object of the course will be to familiarize the student with the life history of the earth, and with the lithological character, order of superposition, periods of deformation, and the areal distribution of the formations which compose the earth's crust.

In addition to the above, some time will be given to surface geology, in which the present contours of the earth's surface will be discussed.

The text book used is Chamberlain and Salisbury's Geology, Vols. II and III. To be preceded by V 2 (Palæontology), and preceded by, or accompanied with Y 3 (Physical and Chemical Geology.

Y 3. Physical and Chemical Geology.

Professor SEAMAN.

Two times a week, sixteen weeks, winter and first half of spring terms. To count as four-tenths of a credit.

The instruction in Physical Geology is intended to be especially adapted to the needs of the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman, and all others who desire to understand the connection and the structural relations that rock masses have to one another and to the valuable deposits which they may contain. It treats of the origin and alterations of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, cleavage, mountain building, eruptive rocks and crystalline schists; the action of air, surface and underground waters, and life; the interior condition of the earth, etc., especially in their relations to the problems that the economic geologist, miner and quarrymen have to meet. The student has brought before him constantly the various problems that arise in practical work and the methods of their solution.

This course enlarges and completes much that is briefly touched upon in the Principles of Geology and in Petrography.

The text book used is Chamberlain and Salisbury's Geology, Vol. I.

Students who take this subject must have completed W 2 (Mineralogy), and X 1 (Petrography) must precede or accompany this subject.

Y 4. Geological Field Work.

Professor SEAMAN and Messrs. BOWEN, HANCOCK, GRANT and HITCHCOCK.

Forty-five hours a week, for the last six weeks of the summer term. To count as one credit.

The work in this course will be confined to a study of the problems presented in the Lake Superior region. Structural interpretation of special areas will be required. The student will be required to map in detail these areas, and to construct maps showing the deformation which the strata have undergone. The origin of the ores and their relation to structure and deformation, such as folding and faulting, will be studied in some detail. They will also be required to give satisfactory evidence of understanding some of the details of metamorphism which the rocks have undergone. Q 1 (Surveying), X 1 (Petrography), Y 2 (Historical Geology) and Y 3 (Physical and Chemical Geology) are required for this subject.

Y 5. Economic Geology.

Mr. BOWEN.

Three times a week, twenty-eight weeks, fall, winter and first half of spring terms. To count as nine-tenths of a credit. Prerequisites, W 3 (Mineralogy), X 2 (Petrography), Y 4 (Field Geology). The course includes a discussion of the genesis of ore-deposits and a careful consideration of the useful metallic and non-metallic minerals; the deposits of the United States receive especial consideration. Foreign occurrences are treated as time will permit.

The aim is to make the course as practicable as possible. To this end the uses, mode of occurrence, distribution, origin, technology and facts which bear upon the commercial value of ores and minerals are especially considered.

Students are required to make abstracts of professional and technical reports for presentation before the class. All students are held responsible for a knowledge of the data given in such report.

The laboratory is well equipped with material representative of the subject from the United States and foreign countries. Students are required to spend sufficient time in the laboratory to thoroughly familiarize themselves with this material.

Y 6. Applied and Mining Geology.

Mr. Bowen.

Three times a week, sixteen weeks, winter term and first half of spring term. To count as five-tenths of a credit.

The course emphasizes the bearing of structural, dynamic and chemical geology and lithology to ore deposits and mining.

The relation of folding, faulting, jointing, etc., to ore deposition and their effects on previously formed ore bodies will be taken up in detail; also a detailed study and interpretation of geologic maps with methods for their construction.

The mode of occurrence, uses and commercial values of the most important non-metallic and metallic products will also be taken up.

This course must be preceded by W 4 (Elementary Mineralogy and Crystallography) and Y 1 (Principles of Geology).

Y 7. Field Geology.

Professor Seaman and Messrs. Bowen, Hancock, Grant and Hitchcock.

Forty-five hours a week for last six weeks of the summer term. To count as one credit. The instruction in this subject begins about the middle of July, and consists of six weeks' practical work in the field. The work is practically confined to the Pre-Cambrian rocks of the Lake Superior region.

A few days of the course are spent at compass work, in which the student is trained in the use of the dial and dip compasses and aneroid barometer. This work consists of running section lines, meandering roads and streams, and platting outcrops; in fact, making a complete map of the traverses. Specimens are collected and located with reference to some monument establishd by the

United States linear survey. The student plats all of his work in the field, keeping his latitude and departure by means of his compass course and pacing.

Considerable time is spent in the study of the older granites, gneisses and hornblende schists, etc., with their varied accompaniment of tuffs and basic and acid intrusives which comprise the basement complex. Here the various acid and basic dike rocks are studied in their relation to one another and to the older schists. Vein phenomena are also studied at the various openings along the gold range northwest of Ishpeming.

Most of the time is spent in studying the Huronian clastics that rest uncomformably upon the older Basement Complex. These clastics in the Marquette Iron-Bearing District are found to be capable of division into a lower, a middle and an upper series, termed, respectively the "Lower Marquette," "Middle Marquette" and the "Upper Marquette" series. These series are separated from each other by unconformities. Large bodies of iron ore are associated with the middle and upper series. The ore bodies are studied with reference to their origin, and maps and sections are made showing their mode of occurrence, and their relation to the associated rocks.

The department is well equipped with the instruments necessary for this work, and note books with special rulings are furnished the students at cost.

To be preceded by W 4 (Elementary Mineralogy and Crystallography) and Y 1 (Principles of Geology).

J. THESIS.

The Faculty.

J 1. Thesis.

Properly qualified students may include the preparation of a thesis in their work for a degree. To count as one credit.

The subject of such thesis must be announced with the schedule of studies for the year in which the degree is expected; further, the schedule must be approved by the head of the department in which the thesis work is to be done. This approval will include the subject chosen and the student's preparation to do the work.

The schedule and subject are then considered by the Faculty, whose approval is necessary.

The thesis must be completed by July 1, and submitted to the Faculty for examination and acceptance. For its acceptance it must be accompanied with a written approval of the instructors under whom the work was done.

PHYSICAL TRAINING.

Mr. Stewart.

No argument is needed to establish the proposition that one who desires to do his best work must take reasonable care of his health. High grade intellectual work is dependent on physical condition and it is the part of wisdom to make provision for the maintenance of good health. Nature has decreed that one of the factors on which health shall depend is a reasonable amount of exercise. Where this is not supplied by the individual's occupation it must be obtained by means of athletic games and sports, indoors or out.

The life of the student at the College of Mines is very like that of the business man busy with affairs, and the need of rational physical exercise and mental relaxation is correspondingly great. This fact is recognized and provision is made in the new Gymnasium and Club House for the best kinds of exercise and recreation serving to relax the mind and renew the body, making both more fit for the business in hand.

The class work, which is quite informal, consists of light all around exercise. Those desiring to specialize in some particular line are given opportunity to do so. Recreative games are made a prominent feature, sport for sport's sake being the rule. Use is made of the facilities afforded in the building for social intercourse. Here the students are afforded opportunity to meet and get acquainted with each other outside of the classroom. It also offers opportunity to meet people of the vicinity not connected with the College.

It is confidently expected that the activities centering in the Gymnasium and Club House will add largely to the pleasure of the life of the students and will increase the efficiency of their college work. Instead of finishing the college course with less of physical power they had at the beginning, it is expected that the students

will gain in physical as well as mental vigor and therefore be better fitted to take up difficult work on graduation.

Special instruction in all branches of Gymnastics, Athletics and Games will be given by appointment. The instructor will consult with all who desire his advice on matters of health, physical development and corrective exercises taking such measurements and tests and prescribing such special exercise and treatment as the case may require.

DEGREES

The approximate unit of a credit is assumed to be three hours a week in the class room (approximately nine hours of total work) or nine hours a week in the laboratory for thirty-three weeks. A subject scheduled for more or less time than here indicated takes its proportionate credit. No partially completed course may be accepted for credit either in whole or in part. The College is in session for four terms each year. It is therefore possible for a properly prepared student to cover the ordinary twelve term or four years' engineering course in three calendar years.

The degree of Engineer of Mines is offered under the following conditions: The candidate must have been a resident student of this institution for at least one full year of forty-five weeks. He must have obtained a minimum of twenty-five credits, including subjects R 1 (Principles of Mining), W 4 (Elementary Mineralogy and Crystallography) and Y 1 (Principles of Geology). The list of credits on which application for a degree is based, must be approved by the Faculty. A diploma fee of twenty-five dollars must be paid prior to August first of the year in which the candidate expects the degree.

Candidates who are accepted for the degree of Engineer of Mines may, upon application, receive the degree of Bachelor of Science. A diploma fee of fifteen dollars must be paid prior to August first of the year in which the candidate expects the degree.

Conditions relating to the degrees of Bachelor of Science and Engineer of Mines as printed in the year book for 1905-06 will hold for all students who enter the college previous to July 1, 1907.

EMPLOYMENT

To one contemplating entering upon training for any particular profession, the question, will it pay? is one of deep and often of disproportionate interest. In reference to a Mining Engineering training this question generally resolves itself into the more specific inquiry; what are the chances of obtaining a position upon graduation? Regarding this question it may be said that, with the increasing interest in mines and mining, in this and other countries, the demand for competent mining men is on the increase, and at the present time it seems that Mining Engineering offers opportunities at least as wide as are offered by any other line of engineering.

It should be clearly understood that the Michigan College of Mines makes no promise whatever to secure positions for its graduates. Upon graduation each man goes into the market to sell his services, meeting the same conditions as every other technical graduate in mining, whether prepared at this or another college. At the same time the College takes an interest in its graduates. Each one is urged to keep the institution informed of his whereabouts, his work, and whether or not he desires a change. From information thus gained a record is made and kept as nearly up to date as possible. When the College is asked to recommend a man for a given position, this record is looked over and the most available man is selected from it. In no case is a man recommended merely because he is a graduate of this institution. In selecting him his experience, his character and his general ability, both as shown in his work as a student and in his career after he leaves College, are taken into account. His defects, if known, are stated as carefully as are his aptitudes or excellencies, and no one is recommended unless he is deemed fit for the position.

Prospective students and those responsible for them should understand that the College cannot impart traits of character. The best it can do is to help the student develop properly those characteristics which he already possesses. His advancement in his profession will depend quite as much upon his character and ability as

upon his technical training, whether gained in college or out of it. When through his college course, he will, if his work has been properly done, be ready to begin his career in mining.

The location of this institution and its methods of instruction fit its graduates to be useful to their employers in some capacity at the start, and so far they have upon graduation experienced no difficulty in obtaining positions which give them a chance to show forth the material of which they are made. Subsequent advancement depends upon the character and the ability of the individual. His industry and the faithfulness with which he devotes himself to the interests of his employer are two most important factors.

In conclusion it may be said that only those who are willing to do hard and continuous work, both during their course at college and in the years following, should undertake to train for a career in mining. For those who are thus willing, and who have an aptitude for engineering pursuits, the outlook is promising.

LIBRARY

The Library, located on the second floor of Hubbell Hall, is designed to supplement the class work in the various departments of the College. Care has been taken to supply it with the best reference books as well as with the latest publications on the subjects taught, since it is of prime importance that instructors and students shall have access to the results of the most recent researches in scientific and technical lines. It should be noted in this connection that there is no other library in the vicinity to which those needing such information can apply. The Library is especially rich in files of journals relating to the various branches of mining engineering. Upon its shelves may be found complete sets of such journals as Transactions of the American Institute of Mining Engineers, Annales des Mines, Jahrbuch für das Berg-Huetten und Salinenwesen, Journal of the Iron and Steel Institute, Philosophical Transactions of the Royal Society of London, Proceedings of the Royal Society of London, Wiedemann's Annalen der Physik und Chemie, Zeitschrift für Analytische Chemie, Transactions of the American Society of Mechanical Engineers, Zeitschrift des Vereins deutscher Ingenieure, and many others of like character.

A card catalogue of authors and subjects which has been under way for some time is now complete, rendering the Library more valuable. The classification is an adaptation of the Dewey decimal system to the needs of a technical library.

There are now on the shelves 21,122 volumes. The Library receives as gifts a number of United States documents and reports of various state geological surveys and mining bureaus. Such material is very useful, and grateful acknowledgment is made for all contributions of scientific value.

Besides the bound volumes on the shelves, the Library contains over 4,700 pamphlets, classified and accessible for reference, and about 1,350 maps.

There are on file 255 technical and scientific periodicals, which are issued upon application for use in the reading room which adjoins the Library.

The Library is open daily throughout the year, Sundays and legal holidays excepted. While it is intended primarily as an aid to college work, the College authorities are pleased to extend its privileges to such part of the general public as may wish to use it. Mining engineers, and those interested in scientific or technical pursuits, will find it a valuable aid in research work.

BUILDINGS

The laboratories and the library of the College together with its lecture and recitation rooms at present occupy seven buildings.

Hubbell Hall, formerly known as Science Hall, is constructed of Portage Entry sandstone and has extreme dimensions of 109 by 53 feet, with a wing 37 by 25 feet. It contains the executive offices, the library and reading room, and the laboratories and lecture rooms of the departments of Geology, and of Mathematics and Physics.

The physical laboratories are located on the ground floor. They have been recently fitted up with modern conveniences for laboratory instruction. There is a massive pier for instruments requiring extreme stability, while slate shelves firmly attached to the thick basement walls afford very stable support for galvanometers and other like instruments. These rooms contain many features especially designed by the instructors in charge to meet the peculiar needs of this department. They are well lighted and well adapted to their purpose.

On this floor in the tower is a constant temperature and dark room surrounded by thick stone walls. It is used partly for work in light, and partly for electrical and other measurements where a steady temperature is desirable.

The Physical lecture room is located on the second floor of this building and contains a convenient lecture table fitted with electrical, gas and water supply.

The laboratories of the department of Geology and Mineralogy together with the necessary offices occupy the entire first floor.

The library, reading room and executive offices are on the second floor, while the Mathematical lecture and recitation rooms and a Geology and Mineralogy Museum occupy the entire third floor.

The Chemistry Building is 115 by 45 feet, with wings 36 by 17 feet and 53 by 36 feet in size. It is a brick and stone structure of three stories in height.

This building has a forced draft ventilation system.

It contains the laboratories for General Chemistry, Qualitative Analysis, Quantitative Analysis, and for special work, together with chemical lecture room and the necessary recitation and supply rooms.

The Assay Laboratory is a brick structure 99 by 24 feet in size, standing north of Hubbell Hall. It contains a general furnace room 56 by 21 feet in the center of the building. The western end is occupied by a supply room 15 by 13 feet and a weighing room 12 by 21 feet. In the eastern end of the building there is a parting room 10 by 21 feet, fitted with desks and hoods for the parting of gold and silver. This building connects by a covered passage-way with the Chemistry Building which adjoins it.

The Mechanical Engineering Building, of brick and stone, is of the extreme dimensions 101 by 64 feet. It contains the room used by the department of Mechanical and Electrical Engineering. The Mechanical Drawing room on the second floor of this building is an exceptionally well lighted room and well adapted to its purpose. In addition the building contains the wood-working shop, the machine shop, electrical laboratory, testing laboratory, together with lecture and recitation rooms.

A wing contains a fuel room 36 by 16 feet and a boiler room 33 by 29 feet. In the latter are located the boilers which supply heat and power to the whole institution. There are three, two of the water tube type and one of the return tubular type.

A second wing 43 by 26 feet in size has been constructed to accommodate a blacksmith shop.

The Ore Dressing Building is a wooden structure with main part 30 by 30 feet, two stories in height and an extension 51 by 30 feet. It occupies a slope on the eastern side of the College grounds which gives the requisite fall for gravity processes.

There is also a Reverberatory Roasting Furnace in a wooden building 28 by 28 feet. This furnace is operated in connection with the Ore-Dressing mill.

The Mining Engineering Building is 134 by 53 feet, three stories in height, and is built of brick and stone. In the center of the building there is a tower which carries a large steel tank at the top, thus providing a water supply for the Hydraulic Laboratory which is located in this building. There are eight floors in the tower which are used for experimental work in hydraulics, for further description of which see course Q 3 (Hydraulics).

There are also in this building a mining engineering laboratory, a very large mapping and instrument room, a model room and mining lecture room.

The Metallurgy Building is a three-story building of stone and brick, extreme dimensions 82 x 34½ feet. It is equipped with furnaces and apparatus for laboratory work in metallurgy and in ore dressing. There is also a collection of ores, metallurgical products, refractories and fuels used for demonstrating the lectures and for study.

There is to be provided a separate furnace building, equipped with a blast-furnace for actual practice in smelting ores.

College Club House and Gymnasium.—Generous friends of the College of Mines, including the members of the Board of Control, have joined with the staff and students in providing the College with a handsome building to be used as a College Club House and Gymnasium. This building was completed in the winter of 1906. It is commodious and admirably adapted to serve its dual purpose.

The gymnasium is 45 x 90 feet in the clear and 24 feet from floor to ceiling. A running gallery is suspended 11 feet from the floor. The lighting both for day and night use is exceptionally good. The necessary locker and bath rooms with modern appliances are provided. The gymansium may be transformed into an auditorium, a full complement of opera seats being provided for such needs.

There are ample club rooms finished in attractive style, and space is provided for the installation of bowling alleys. The building has been designed to serve also as a suitable place for such social functions as are given by the students of the institution. Altogether it will be the center of the College life outside of classroom and laboratory and will contribute very materially to the social life of the students. Those who have so generously donated to the fund for providing for this Recreation Hall are deserving of the highest praise for their substantial appreciation of the needs of the College.

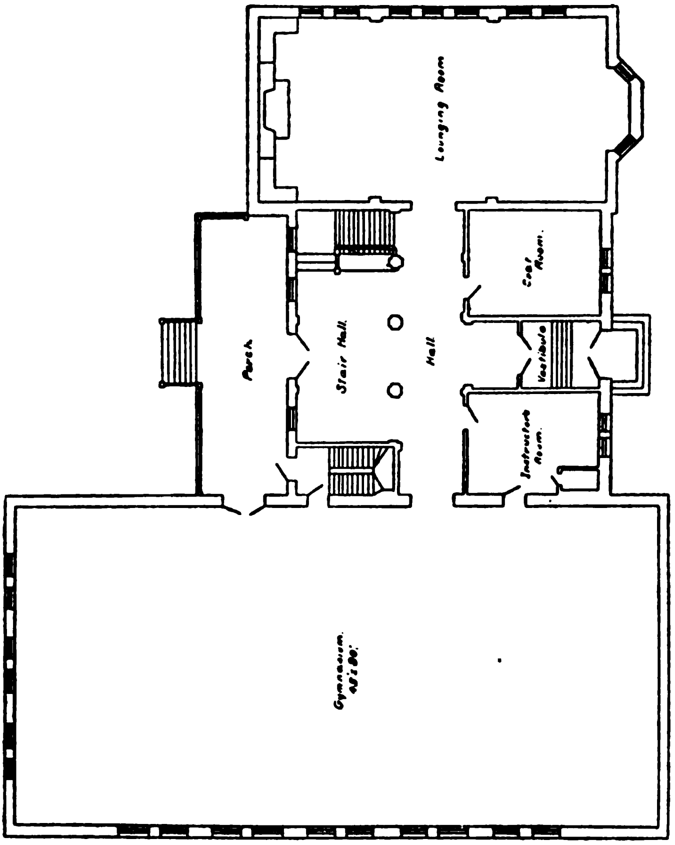
The gymnasium is provided with a carefully selected equipment of the most modern apparatus of standard makes. The Club House portion of the building is furnished and decorated in a most attractive manner.

The building was placed in commission during the winter term of 1906 and is rapidly justifying the faith of those friends who labored so disinterestedly to provide it.

The instructor in physical training is the director of this building and all of its activities are in his immediate charge.

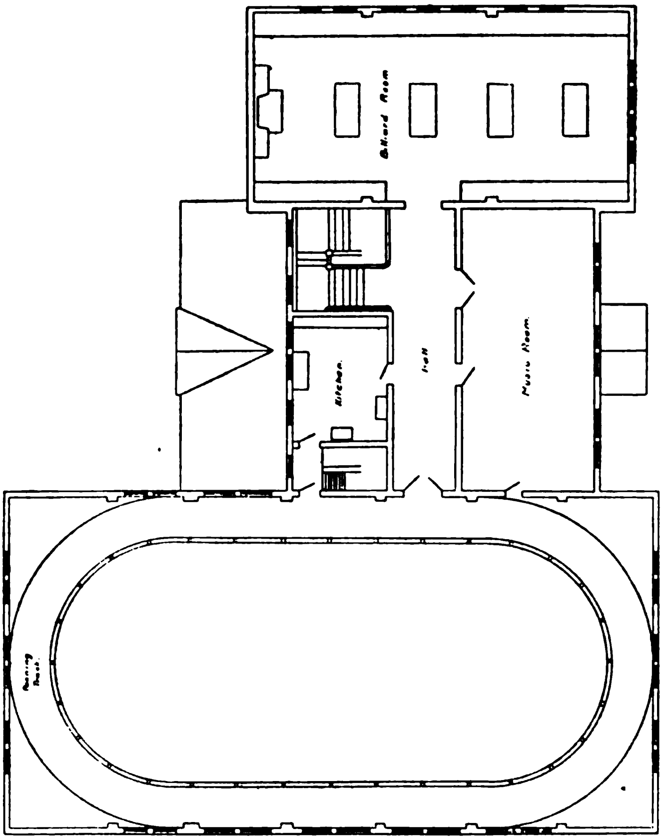
The accompanying floor plans exhibit the general arrangement of this building.

[redacted]



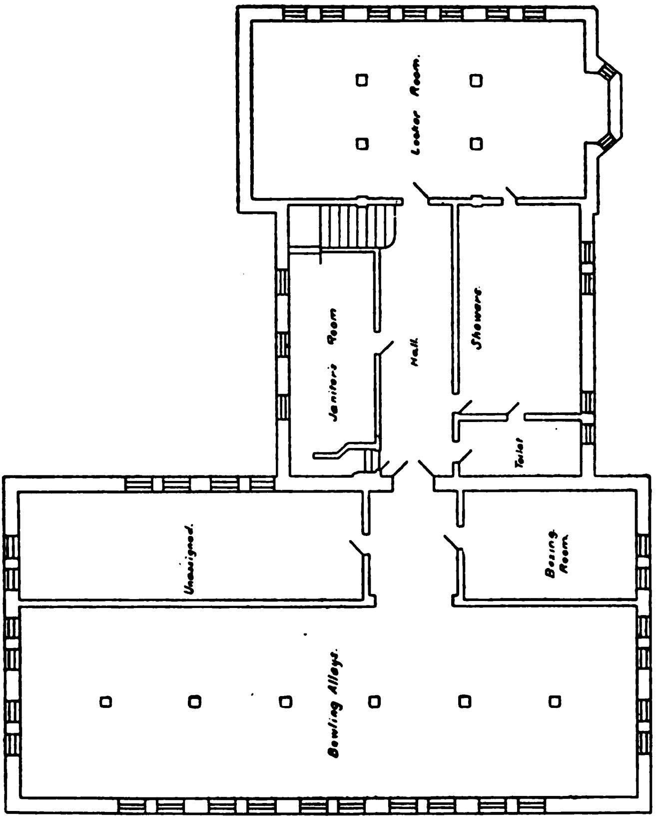
FIRST FLOOR

[redacted]



SECOND FLOOR

[redacted]



BASEMENT

TUITION, DEPOSIT AND OTHER EXPENSES

The Michigan Legislature of 1897 required the Board of Control to charge matriculation, tuition and laboratory fees. Since the people of Michigan had by taxation paid for the College buildings and equipment, it was thought by the Legislature, that those persons whose homes were outside the State, ought justly to pay higher matriculation and tuition fees than the residents of the State.

The law provides that the matriculation fee "Shall be not less than ten dollars for all persons who have been bonafide residents of this State for not less than one year immediately preceding their matriculation as students in said institution, and not less than twenty-five dollars for all others; and that tuition shall be twenty-five dollars per year to resident students, as above defined." Tuition for all others is one hundred-fifty dollars per year.

All expenses for breakage or damage to apparatus will be paid for by the student, as the laboratory fees do not cover these items.

The matriculation fee must be paid on entrance to the College. The full tuition fee for Michigan students must be paid on entrance, and applies to the unexpired portion of the year in which it is paid. Other students are required to pay the proportionate part of the tuition fee at the commencement of each term, for that term as follows: Fall, winter and summer terms, $40.00 each term. Spring term, $30.00.

An incidental fee of $2.50 per term on account of the College Club and Gymnasium is required of all students, and is paid at the beginning of the term to which it applies.

Laboratory fees are due when the course involving the laboratory work begins. They must be paid before the student can be admitted to the laboratory.

No partial fee can be accepted, and any fee once paid can not be refunded except in the case of protracted illness.

A student suspended, dismissed or expelled from, or voluntarily withdrawing from a class, laboratory, or the College, forfeits the fees already paid.

The scale of fees is as follows:

TITLE	Resident.	Non Resident.
Matriculation Fee	$ 10 00	$ 25 00
Tuition Fee, annually	25 00	....
" " Fall term	....	40 00
" " Winter term	....	40 00
" " Spring term	....	30 00
" " Summer term	....	40 00
LABORATORY FEES		
B 1—Physics	3 00	3 00
B 2—Physical Measurements	2 00	2 00
B 3—Electrical Measurements	3 00	3 00
B 4—Physics	2 00	2 00
F 1—Chemistry	10 00	10 00
F 2—Blowpipe Analysis	1 00	1 00
F 3—Qualitative Analysis	10 00	10 00
F 4—Volumetric Analysis	3 00	3 00
F 5—Quantitative Analysis	10 00	10 00
F 6—Synthetic Chemistry	10 00	10 00
F 7—Quantitative Analysis	7 00	7 00
G 1—Assaying	15 00	15 00
G 3—Metallurgical Laboratory Practice	10 00	10 00
G 7—Practice Work in Metallurgy	5 00	5 00
M 2—Shop Practice	10 00	10 00
M 3—Design of Structural Joints	50	50
M 6—Testing Materials	10 00	10 00
M 9—Mechanical Laboratory	10 00	10 00
M 15—Mechanical Drawing	1 00	1 00
M 16—Machine Drawing	1 00	1 00
N 3—Electrical Engineering Laboratory	5 00	5 00
Q 1—Surveying	10 00	10 00
Q 3—Hydraulics	5 00	5 00
Q 4—Topographical Drawing	1 00	1 00
Q 5—Surveying	2 00	2 00
R 3—Mine Surveying Practice	10 00	10 00
S 2—Ore Dressing	5 00	5 00
S 3—Practice Work in Ore Dressing	10 00	10 00
V 2—Palæontology	5 00	5 00
W 1—Crystallography	2 00	2 00
W 2—Mineralogy	10 00	10 00
W 3—Mineralogy	5 00	5 00
W 4—Elementary Mineralogy and Crystallography	7 00	7 00
X 1—Petrography	5 00	5 00
X 2—Advanced Petrography	5 00	5 00
Y 4—Field Geology	5 00	5 00
Y 7—Field Geology	5 00	5 00
Gymnasium (each term)	2 50	2 50

In order partially to insure the State against damage and loss to its college property every student is required to deposit with the treasurer before entering the college, the sum of twenty-five dollars ($25). This sum cannot be withdrawn by the student until he closes his connection with the institution, and if any portion is required as a refund for damages, the part withdrawn must be at once replaced by the student.

Charges for apparatus, chemicals and other supplies from the store rooms, as well as for repairs of damages to college property, and also fines, are deducted from coupons procurable from the secretary, but no portion of the deposit of twenty-five dollars may be used for the purchase of these coupons. The coupons can be used only for the purposes mentioned, and not for the payment of any fees. The permanent deposit of twenty-five dollars, together with any balance equivalent to the unused portion of a coupon, is returned to the student when he closes his connection with the institution.

There are no dormitories connected with the College. Arrangements can be made to obtain board and room in private families, and in boarding houses, at prices varying from twenty-five dollars per calendar month upward. This is to include the room, heat and light, as well as board. Board alone can be obtained at about twenty dollars per calendar month. The College expenses vary much with the taste and habits of the student. With care the cost to a Michigan student need not exceed $450.00 per year.

REGULATIONS

Choice of Subjects.—Upon entering the College the student will present his choice of subjects for the year.

On or before the last Saturday of the College year, all students intending to remain during the coming year will hand to the secretary duplicate written lists of subjects chosen for that year. All candidates for a degree are required to take courses R 1 (Principles of Mining), and Y 1 (Principles of Geology). Apart from these the choice of subjects is governed by the following regulations:

In selecting the subjects for any year the student must observe the schedule both for terms and hours as given in the tables at the end of the catalogue. He must also pay attention to the proper sequence of subjects and avoid choosing subjects for which he has not covered the required preceding work. In exceptional cases a student may be allowed to take a subject out of its order, but when the work is so taken, no credit will be given for it until the required preparatory work has been made up.

After the subjects have been chosen for the year, a student can change, drop or take up any study only in the following manner: He is to hand to the secretary a written request, stating the change desired and the reasons therefor. This petition before it is given to the secretary is to bear the written approval of the heads of departments whose work is affected by the proposed change. If it is then approved by the president, the change may be made, and the secretary will give the student a notice which he is to show to the instructors interested before any change in the attendance upon classes is made. The work already done in the subject from which the change is made will not be counted, and the student must complete the required work in the subject to which he is transferred, as if the latter subject had been originally chosen.

A student who drops or takes up a course except in the manner here stated will be considered as having withdrawn from the College, and will stand suspended from all exercises in the institution.

If at any time a student is found to have work insufficient to properly occupy his time, he may be required to take additional subjects. If a student has taken up more work than he can properly perform he may be required to drop some of the subjects.

Each instructor is the sole judge of the fitness of every student applying for admission to his classes. He may refuse to admit any student found deficient in preparation, or dismiss him from his courses at any time when his conduct or work is unsatisfactory.

The student who intends to complete his work at the College in three years (see under Degrees) should take the following subjects in his first year:

A 1. Algebra.
A 2. Plane Trigonometry.
A 3. Spherical Trigonometry.
A 4. Analytic Geometry.
B 1. Physics.
F 1. General Chemistry.
F 2. Blowpipe Analysis.
M 15. Mechanical Drawing.
Q 1. Surveying.
Q 4. Topographical Drawing.
R 1. Principles of Mining.
W 4. Elementary Mineralogy and Crystallography.
Y 1. Principles of Geology.

The schedule for the second year may well be as follows:

A 5. Differential and Integral Calculus.
B 4. Physics.
C 1. Analytic Mechanics.
F 3. Qualitative Analysis.
M 1. Properties of Materials.
M 2. Shop Practice.
M 5. Mechanical Engineering I.
M 11. Mechanical Engineering II.
M 16. Machine Drawing.
Q 6. Graphical Statics.
R 2. Mine Surveying and Mining.
R 3. Mine Surveying and Mining—Practical Work.
W 1. Crystallography.
W 2. Mineralogy.

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In the third year there is possible a considerable latitude of choice, according to the student's purpose. For a fundamental course of broad application to the mining field the schedule for this year may be as follows:

B 5. Light.
C 2. Analytic Mechanics.
F 4. Volumetric Analysis.
F 7. Quantitative Analysis.
G 1. Assaying.
G 2. Metallurgy.
M 4. Mechanics of Materials.
M 10. Pumps and Pumping Machinery.
R 5. Mine Management and Accounts.
S 2. Ore Dressing.
S 3. Practice Work in Ore Dressing.
X 1. Petrography.
Y 3. Physical and Chemical Geology.

Absences.—All absences bring a daily mark of zero, until the work missed is made up.

A student absenting himself without excuse for more than ten per cent. of the work of any course in any term thereby dismisses himself from the College. In the case of field or laboratory courses, the limit is five per cent. instead of ten per cent.

Each tardiness counts a half absence.

Passing Grade.—A student must obtain a grade of 75 on the scale of 100 to obtain credit for any course. In case of failure to pass or complete a subject, the work can be made up only when this subject is being regularly given.

Failure.—A student failing to make a passing grade in three of the subjects in any year's work, is thereby dismissed from the College.

Laboratories.—The laboratories close Friday evening, the closing day of each term, and re-open on Monday morning after the recesses.

PRIZES AND SCHOLARSHIPS

THE LONGYEAR PRIZES.

Through the liberality of Hon. J. M. Longyear, of Marquette, the following prizes have been offered, as stated in his letter which is here appended.

MARQUETTE, MICH., Nov. 9, 1887.

Charles E. Wright, Esq., Marquette.

DEAR SIR—I wish to offer three first prizes of seventy-five dollars ($75) each, and three second prizes of fifty dollars ($50) each to be competed for by the members of the senior class of the Michigan College of Mines. The competition to be by means of papers on three subjects, written by members of the class, and submitted to the Board of Control for examination in such a manner and at such a time as the Board may determine. I desire subjects selected with a view of producing papers which will be of practical use in developing the mineral resources of the State of Michigan. I should like something which would be of service to the average woodsman or explorer, and suggest the subjects of Practical Field Geology, and the use of the Dial and Dip Compass in explorations; leaving the selection of the third subject to the judgment of the Board. If this offer is accepted and there are two or more papers on each subject submitted, I will pay seventy-five dollars to each of the writers of the three papers which may be awarded the first prizes, and fifty dollars to each of the writers of the three papers which may be awarded the second prizes.

I would suggest, however, that in case only two papers are submitted, the Board reserve the right of awarding only one prize, in case such action should seem advisable. In case only one paper should be submitted, I should like the Board to exercise its judgment in awarding a prize. It is my desire to publish the papers under the writer's name, in pamphlet form, for distribution among miners, explorers, land owners and others.

Yours very truly,

J. M. LONGYEAR.

In conformity with the foregoing letter, the Board of Control have decided upon the following subjects and conditions:

Subjects.

1. Field Geology; its Methods and their Applications.
2. The Dial and the Dip Compass and their Uses.
3. The Diamond Drill and its Uses.

The conditions under which the prizes are awarded are as follows:

The papers are to be presented by August 15th, for each year.

A student may present a paper upon each of the three subjects, which will entitle him to three prizes, if his papers are found worthy.

The dissertations must be prepared in the same manner as the theses, the regulations for which can be procured on application to the secretary of the College.

The title page is to have upon it an assumed name, and each paper is to be accompanied with a sealed envelope bearing the same name. This envelope must contain the writer's true, as well as assumed name, and his address. It will not be opened until the awards have been made.

No prizes will be awarded, unless the papers are judged by the committee to whom they are referred, to be of a sufficiently high standing to be entitled to a prize; hence, there may be awarded all, part, or none of the prizes, as the case may be.

These prizes can now be competed for by any student of the College, whether special, graduate or regular, without restriction to the graduating class, as was originally specified.

THE CHARLES E. WRIGHT SCHOLARSHIP.

The Charles E. Wright Scholarship was founded by Mrs. Carrie A. Wright, of Ann Arbor, in accordance with the conditions expressed in the letter which follows:

To the Honorable Board of Control of the Michigan College of Mines.

GENTLEMEN—In memory of my husband, the late Charles E. Wright, and as a token of the deep interest he had in the Michigan College of Mines, I desire to give to said College the sum of one thousand dollars.

If said gift shall be accepted, it is to be held under the following conditions:

To wit: it is to be invested as a permanent fund by the Board of Control to form the nucleus of a scholarship to be known as the Charles E. Wright Scholarship. The income is to be used for the purpose of aiding indigent students by loans under the following regulations: Loans from this income may be granted by the Board of Control upon the recommendation of the Faculty to students who have completed at least one year of study at the Michigan College of Mines, who have for the entire time of this residence a good record as to character and scholarship; who, further, intend to devote themselves to the profession of mining engineering or geology, and who are deemed deserving and needy.

Upon receipt of a loan from this Scholarship the student shall give his note for the amount of same. This note shall bear interest at the rate of five per cent. per annum from the date of his graduation or of leaving the College until paid, and shall be due on or before five years from such date.

Amounts paid on such notes shall go to increase the money to the credit of the Charles E. Wright Scholarship Fund.

(Signed) CARRIE A. WRIGHT.

THE NORRIE SCHOLARSHIP.

This scholarship was founded, and will be awarded in accordance with the conditions and requirements stated below:

Know all men by these presents, That I, A. Lanfear Norrie, of the City of New York, hereby give, grant, assign, and set over unto the Michigan College of Mines, of Houghton, Michigan, and to Peter White, D. H. Ball and J. M. Longyear, of Marquette, Michigan, as trustees, the sum of ten thousand dollars ($10,000), lawful money of the United States.

The conditions of this gift, and upon which this fund is to be taken, are that the said trustees shall invest the same upon bond and mortgage in the Village of Marquette, or in the City of Detroit, in the State of Michigan, or in the City of Milwaukee, in the State of Wisconsin, or in the City of Chicago, in the State of Illinois, upon unincumbered improved real estate.

That one-half of the income of said sum of $10,000 shall be paid yearly by said trustees unto the Board of Control, for the support of some student whose father has worked in, or in some way been

connected with mining operations in the Upper Peninsula of Michigan, who shall be designated by the Faculty of said College; and the remainder of said income shall be accumulated and invested as said principal shall be invested, and that this fund with its accumulations shall be the basis of a larger fund, to be obtained from other contributions, amounting to at least one hundred thousand dollars ($100,000), to be used for the erection of a Dormitory Building for the use of such students as shall be designated by said Faculty; which building, when erected, shall be under the exclusive control of the corporation or Board of Control of the said Michigan College of Mines.

This gift is to the said trustees and their successors forever, for the benefit of said College. In case of the death of either of said trustees, the survivors or survivor shall appoint a successor or successors.

When the erection of said building shall be commenced, after the said fund of one hundred thousand dollars is obtained, the sum hereby given, with all its accumulations, shall be paid over to the said College for the purpose aforesaid.

Witness my hand, the 30th day of January, 1890.

A. LANFEAR NORRIE.

Witness, T. E. O. M. STETSON.

We, Peter White, D. H. Ball and J. M. Longyear, the persons named in the above instrument, accept the trust therein granted, in all respects, and agree to comply with the conditions thereof.

Witness our hands, the 1st day of February, 1890.

PETER WHITE,
D. H. BALL.
J. M. LONGYEAR.

THE LONGYEAR FUND.

This is a fund of $2,500, given by the Honorable J. M. Longyear, of the Board of Control, to be the property of the College of Mines, to be used in aiding students of the College by loans in cases where the said students are unable to maintain their connection with the College without such aid.

The conditions governing loans from this Fund are as follows: Loans may be granted by the Board of Control, upon the recom-

mendation of the Faculty of the College to students who have completed at least one term of study at the College of Mines, who have for the entire time of residence a good record as to character and scholarship, who are deemed worthy and needy, and who shall be recommended by two responsible persons not connected with the College.

Upon receipt of a loan from this fund, the student shall give his note for the amount of same. This note shall bear interest at the rate of five per cent. per annum for the first three years from the date of his graduation or his leaving the College, and for the following two years at the rate of seven per cent. per annum. It will then be due.

This method of loaning is believed by the donor and the College to be of more benefit to the student than a gift outright, since it gives him the opportunity to pay for his own education while offering him assistance when he most needs it. It is thought that it would be better if all funds given to the College for the aid of students were accompanied with a proviso that the proceeds should go as a loan to the student rather than as a gift. Certainly the manly student hesitates to receive aid which savors of charity. It is a kindness if he can be aided in a way that will save his self-respect.

THE ALLIS-CHALMERS COMPANY SCHOLARSHIP.

The Allis-Chalmers Company of Milwaukee and Chicago, the great manufacturers of heavy and mining machinery, offer to one or two members of each graduating class a scholarship which includes employment by them for a time under conditions which offer unusual opportunity for practice with mining machinery, and for becoming familiar with the requirements of mines in this particular, together with a reasonable compensation for the time employed.

This scholarship is open to graduates who have shown sufficient proficiency in mechanical lines to warrant their receiving it and who have applied to the Faculty for recommendation thereto as early as July 15th of the year in which their degrees are granted.

MICHIGAN LOAN SCHOLARSHIPS.

By virtue of the power conferred by Act No. 81, Public Acts of 1897, the Board of Control have established twelve scholarships under the above title. These are open to Michigan students under the following regulations:

The scholarship may be granted by the Faculty of the College to students who are bona-fide residents of the State of Michigan, who have completed at least three terms of study at the College of Mines, who have during this entire time a good record as to character and work as students, and who are deemed deserving and needy.

Each scholarship is to be granted for the College year or the unexpired portion thereof, but the same student may at the option of the Faculty receive the grant more than once.

Each scholarship shall remit to the recipient the tuition and laboratory fees for the time for which he holds it, provided, however, the amount so remitted shall not exceed $75 in any one college year.

If at any time the work or conduct of the holder of one of these scholarships becomes unsatisfactory to the Faculty, he shall be deemed to have forfeited the scholarship.

Upon receiving the grant of a scholarship the recipient shall give his note for the amount of same. The note shall bear interest at the rate of six per cent. per annum from the date of his leaving the College until paid, and shall be due on or before five (5) years from such date.

Amounts paid on such notes shall constitute a fund to be known as the Loan Scholarship Fund, which fund shall be devoted to assisting needy and worthy students by cash loans.

TEXT AND REFERENCE BOOKS

A. MATHEMATICS.

A 1. College Algebra. G. A. Wentworth. Ginn & Co., Boston.

A 2 and 3. Plane and Spherical Trigonometry. W. Wells. Heath & Co., Boston.

A 3. Manuscript Notes. Issued by the department.

A 4. Analytic Geometry. Tanner and Allen. American Book Co., New York.

A 5. Differential and Integral Calculus. J. M. Taylor. Ginn & Co., Boston.

A 6. A Treatise on Ordinary and Partial Differential Equations. W. W. Johnson. John Wiley & Sons, New York.

B. PHYSICS.

B 1. Elementary Mechanics. G. A. Merrill. American Book Company, New York.

B 1 and 4. Manuscript Notes in Physics. Issued by the department.

B 1 and 4. Heat and Light. R. T. Glazebrook. The Macmillan Co., New York.

B 4. Elementary Electricity and Magnetism. D. C. and J. P. Jackson. The Macmillan Co., New York.

B 2 and 3. A Laboratory Manual of Physics and Applied Electricity. E. L. Nichols. The Macmillan Co., New York.

B 2. Lessons on Elementary Practical Physics. Vols. I and II. Balfour Stewart and W. W. Haldane Gee. The Macmillan Co., New York.

B 3. Electrical Measurements. H. S. Carhart and G. W. Patterson, Jr. Allyn & Bacon, Boston.

C. MECHANICS.

C 1 **and** 2. Mechanics of Engineering. I. P. Church. John Wiley & Sons, New York.
Manuscript Notes and Examples. Issued by the department.

F. CHEMISTRY.

F 1. Chemistry Simplified. George A. Koenig. H. Cairey Baird & Co., Philadelphia.
F 1. Inorganic Chemistry. Richter, Smith. P. Blakiston, Son & Co., Philadelphia.
F 1. Treatise on Chemistry. Roscoe and Schorlemmer. D. Appleton & Co., New York.
F 2. Manual of Determinative Mineralogy. Edition 13. George J. Brush. John Wiley & Sons, New York.
F 2. Landauer's Blowpipe Analysis. 1892. Translated by James Taylor. The Macmillan Co., New York.
F 3. Notes on the Chemistry of Metals and the Analytical Relations of the Metallic Compounds. G. A. Koenig.
F 4. Electrolytic Methods. E. F. Smith. J. B. Lippincott Co., Philadelphia.
F 6. Theoretical Chemistry. Ira Remsen. Lea Bros. & Co., Philadelphia.
F 6. Elements of Physical Chemistry. H. C. Jones. The Macmillan Co., New York.
F 6. Introduction to Physical Chemistry. J. Walker. The Macmillan Co., New York.
F 7. Quantitative Chemical Analysis. By the late Dr. C. Remigius Fresenius. Translated and amplified by A. I. Cohn. John Wiley & Sons, New York.

G. METALLURGY.

G 1. Manuscript Notes on Assaying. 1895. George A. Koenig.
G 1. The Fire Assay. L. S. Austin, Mining and Scientific Press, San Francisco, 1907.
G 1. Manual of Assaying. A. S. Miller. Engineering and Mining Journal Co., New York.

G 2. Introduction to the Study of Metallurgy. Roberts-Austen. J. B. Lippincott Co., Philadelphia.

G 2. Metallurgy of the Common Metals. L. S. Austin. Mining and Scientific Press Co., San Francisco.

G 2. Metallurgy of Lead. Last Edition. H. O. Hofman. Scientific Publishing Co., New York.

G 2. Modern American Methods of Copper Smelting. Last Edition. E. D. Peters. Scientific Publishing Co., New York.

G 2. Fuel and Refractory Materials. A. H. Sexton. Blackie & Sons, London.

G 2. Metallurgy of Zinc. W. R. Ingalls. Engineering and Mining Journal Co., New York.

G 2. Cyanide Practice. A James. Engineering and Mining Journal Co., New York.

G 2. Metallurgy of Gold. T. K. Rose. J. B. Lippincott & Co., Philadelphia.

G 2. Metallurgy of Silver. H. F. Collins. J. B. Lippincott & Co., Philadelphia.

G 2. Handbook of Metallurgy. C. Schnabel. Translated by H. Louis, 1905. The Macmillan Co., New York.

G 2. The Cyanide Process. J. Park. J. B. Lippincott & Co., Philadelphia.

G 2. Industrial Furnaces. Damour. Hill Pub. Co., New York.

G 2. Metallurgical Calculations. Joseph W. Richards, 1906. McGraw Publishing Co., New York.

G 3. Metallurgical Laboratory Notes. H. M. Howe. Engineering and Mining Journal Co., New York.

G 5. Corporate Management. Conyngton. The Roland Press, New York.

M. MECHANICAL ENGINEERING.

M 1 and 6. The Materials of Construction. J. B. Johnson. John Wiley & Sons, New York.

M 2. Pattern Maker's Assistant. Joshua Rose. D. Van Nostrand Co., New York.

M 2. Modern Machine Shop Tools. Vandervoort. N. W. Henley Co., New York.

[redacted]

M 4. Text-Book on the Mechanics of Materials. Mansfield Merriman. John Wiley & Sons, New York.

M 4. "Cambria Steel."

M 5. The Mechanical Engineering of Power Plants. F. R. Hutton. John Wiley & Sons, New York.

M 6. Hydraulic Cement. F. P. Spalding. John Wiley & Sons, New York.

M 9. Experimental Engineering. R. C. Carpenter. John Wiley & Sons, New York.

M 10. Pumping Machinery. W. M. Barr. J. B. Lippincott Co., Philadelphia.

M 12. The Steam Engine Vol I, by Heck. D. Van Nostrand & Co., New York.

M 13. Mechanical Engineer's Pocket Book. W. Kent. J. Wiley & Sons, New York.

M 14. Compressed Air and its Application. Hiscox. N. W. Henley & Co., New York.

M 15. Lettering for Draughtsmen. C. W. Reinhardt. D. Van Nostrand & Co., New York.

M 15. Elements of Mechanical Drawing. Last Edition. G. C. Anthony. D. C. Heath & Co., Boston.

M 16. Machine Drawing. Last Edition. G. C. Anthony. D. C. Heath & Co., Boston.

N. ELECTRICAL ENGINEERING.

N 1. Dynamo Electric Machinery. S. Sheldon. D. Van Nostrand and Co., New York.

N 1. Alternating Current Machines. Sheldon & Mason. D. Van Nostrand & Co., New York.

Q. CIVIL ENGINEERING.

Q 1. Field Engineering. Last Edition. William H. Searle. John Wiley & Sons, New York.

Q 1, 4 **and** 5. Theory and Practice of Surveying. Last Edition. J. B. Johnson. John Wiley & Sons, New York.

Q 2 and 3. A Treatise on Hydraulics. Last Edition. Mansfield Merriman. John Wiley & Sons, New York.

Q 4. A practical System of Freehand Lettering. Charles W. Reinhardt. D. Van Nostrand & Co., New York.

Q 6. The Design of Steel Mill Buildings. Milo S. Ketchum. Last Edition. Eng. News Pub. Co., New York.

R. MINING ENGINEERING.

R 1. Elementary Mining and Quarrying. Last Edition. C. Le-Neve Foster. J. B. Lippincott Co., Philadelphia.

R 2. Manuscript Notes on Mine Surveying and Mining. Revised, 1901. F. W. Sperr.

R 4. Manuscript Notes on Mine Engineering. Revised, 1903. F. W. Sperr.

R 5. Manuscript Notes on Mine Management and Accounts. Revised, 1905. F. W. Sperr.

S. ORE DRESSING.

S 2. Ore Dressing. R. H. Richards. Edition of 1903. Engineering and Mining Journal Co., New York.

S 3. Ore Dressing. R. H. Richards. Edition of 1903. (2 Vols.) Engineering and Mining Journal Co., New York.

V. BIOLOGY.

V 2. Comparative Zoology. 1895. James Orton. Harper & Bros., New York.

V 2. A Text-Book of Palaeontology. 1900. Karl Von Zittel. Translated by Charles R. Eastman. The Macmillan Co., New York.

W. MINERALOGY.

W 1. Lecture Notes, by A. E. Seaman.

W 2. A Text Book of Mineralogy. Sixth Edition. 1903. James D. Dana and E. S. Dana. John Wiley & Sons, New York.

W 3. A System of Mineralogy. 1905. E. S. Dana. John Wiley & Sons, New York.

W 4. A Text-Book of Mineralogy. Latest Edition. James D. Dana and E. S. Dana. John Wiley & Sons, New York.

X. PETROGRAPHY.

X 1. Microscopical Physiography of the Rock Making Minerals. Third Edition, 1893. H. Rosenbusch. Translated by J. P. Iddings. John Wiley & Sons, New York.

Y. GEOLOGY.

Y 1. Elements of Geology. Norton. Ginn & Co., New York.

Y 2. Geology. Vols. 2 and 3. Chamberlain and Salisbury. H. Holt & Co., New York.

Y 3. Geology. Vol. 1. Chamberlain and Salisbury. H. Holt & Co., New York.

Y 5. Economic Geology of the United States. H. Ries. The Macmillan Co., New York. Or Ore Deposits of the United States. J. F. Kemp. John Wiley & Sons, New York.

[redacted]

STUDENTS ENROLLED, 1905-1906

Whose names do not appear in the register of students published for that year.

NAME.	RESIDENCE.
Andrews, Richard McGill,	*Yokohama, Japan.*
Bowen, Charles Franklin,	*Houghton.*
Dillaway, Winthrop Chalmers,	*Romeo.*
Duncan, Donald Francis,	*St. Joseph, Mo.*
Hamilton, Theodore Weld,	*Benton Harbor.*
Harrison, Perry Galbraith,	*Minneapolis, Minn.*
Hovland, Joseph T.,	*Zumbrota, Minn.*
Moore, Howard Warren,	*Cleveland, O.*
Richards, James Carver,	*Duluth, Minn.*

REGISTER OF STUDENTS, 1906-1907

NAME.	RESIDENCE.
Abeel, George Howard, Jr.,	*Ironwood.*
Alsip, Albert Arthur,	*Chicago, Ill.*
Ambrose, Charles Wilkins,	*Bay City.*
Anderson, Vern,	*Ionia.*
Andrew, Samuel George,	*Point Mills*
Andrews, Richard McGill,	*Yokohama, Japan.*
Armstrong, Leroy Whitney,	*Ludington.*
Austin, Charles Luther,	*Saginaw.*
Austin, James Buchanan,	*Salt Lake City, Utah.*
Baggaley, William Blair,	*Pittsburg, Pa.*
Barabe, Clifford Aloysius, B.S. (Michigan Collegs of Mines),	*Houghton.*
Barclay, Robert Hargrove, B.E.M. (Kentucky State College),	*Louisville, Ky.*
Barnard, Clarence William,	*Durand.*
Barnum, George, Jr.,	*Duluth, Minn.*
Barr, James Allen,	*Escanaba.*
Bennett, George Nelson,	*Helena, Mont.*
Blodgett, Levant Bentley,	*Hancock.*
Boise, Paul T.,	*Salt Lake City, Utah.*
Bolley, William Remington,	*Eagle River.*
Bolthouse, Henry Charles,	*Ferrysburg.*
Botsford, Clarence Allan,	*Calumet.*
Botsford, Heman L.,	*Calumet.*
Botsford, Milton P.,	*Hancock.*
Boyce, Clarence R.,	*Binghamton, N. Y.*
Brown, Percy Dalles,	*Philadelphia, Pa.*
Buchman, Louis,	*Rapid River.*
Butler, Levi Jonathan,	*Caro.*
Byrne, Harry William,	*Bessemer.*
Calkins, Frederic Ellis,	*Petoskey.*
Campbell, Frank Alvord,	*Kalamazoo.*
Carleton, Edward Jones,	*Minneapolis, Minn.*
Carrigan, James J.,	*Hancock.*
Carroll, William F.,	*Chicago, Ill.*
Cavan, David Brigham,	*Houghton.*
Chadbourne, Humphrey Wallingford,	*Houghton.*
Clausen, Henry William,	*Chicago, Ill.*
Collins, Thomas Hoatson,	*Calumet.*
Cook, Thomas Clair,	*Toledo, O.*

NAME	RESIDENCE
Crabb, James Moorey,	*Detroit.*
Crocker, Bertram Erwin,	*Iron Mountain.*
Dallas, James R.,	*Pittsburg, Pa.*
d'Autremont, Louis Paul,	*Duluth, Minn.*
Davey, William James,	*Bessemer.*
Dentz, Victor Wilfred,	*Milwaukee, Wis.*
DeVlieger, John Alexander,	*Grand Rapids.*
Dickinson, Albert Wright,	*Chicago, Ill.*
Dillon, Harry Thomas,	*Houghton.*
Dobbins, William John,	*Ionia.*
Drake, John Miller, Jr.,	*Chicago, Ill.*
Dunn, Harrison Adam,	*Milwaukee, Wis.*
Earling, Roy Brown,	*Minneapolis, Minn.*
Edyvean, Edmund H.,	*Lake Linden.*
Eichelberger, Frank,	*Cleveland, O.*
Erdlitz, Joseph Frank, Jr.,	*Menominee.*
Ethier, Albert Louis,	*Hubbell.*
Ettlinger, Isador Aaron,	*Chicago, Ill.*
Everheart, Ernest,	*Sherman, Texas.*
Fairbairn, Joseph Walter,	*Streator, Ill.*
Fenwick, William Edward, Jr.,	*Detroit.*
Fitch, Cecil A.,	*Beacon.*
Fitch, Walter Aubrey,	*Beacon.*
Fochtman, Edward Frank,	*Petoskey.*
Fox, Arthur Cristof,	*Houghton.*
Freeman. Lawrence Kimball,	*Flint.*
Friedman, Myron,	*Chicago, Ill.*
Funkey, Charles Howard,	*Hancock.*
Gerry, Alex LeRoy,	*Danbury, Conn.*
Gibbs, Chester Alma,	*Houghton.*
Gibbs, Harry,	*Houghton.*
Gilbert, Isaac Leggett,	*Detroit.*
Glass, Frank A.,	*Butte, Mont.*
Gleason, Adelbert John,	*Biwabik, Minn.*
Goodkind, Leon Edward,	*Helena, Mont.*
Goodman, George William,	*Ishpeming.*
Gordon, Adam R.,	*Kenilworth, Ill.*
Grace, Harry Holder, Jr.,	*Superior, Wis.*
Graham, Ernest R.,	*Croswell.*
Hallingby, Ole,	*Calumet.*
Halter, Richard Grant,	*Chihuahua, Mex.*
Harrison, Perry Galbraith,	*Minneapolis, Minn.*
Heine, Harry William,	*St. Paul, Minn.*
Hellberg, Edward Adolf,	*Norway.*
Hellier, William Guildford,	*Grass Lake.*
Hennes, Frank,	*Houghton.*
Hermann, Charles Frederick,	*Calumet.*

NAME	RESIDENCE
Hermann, Edward Leo,	*Calumet.*
Hicks, Bert Reed,	*Oshkosh, Wis.*
Hill, Roy Nathan,	*Caseville.*
Hines, Pierre Rossiter,	*Socorro, N. Mex.*
Hirshberg, Frank,	*Helena, Mont.*
Hitchcock, Clarence Horace, E.M. (Michigan College of Mines),	*Ludington.*
Hodge, Walter Roberts,	*Houghton.*
Holden, Edgar Freeborn,	*Detroit.*
Holdorf, Bernard Charles,	*Bessemer.*
Holman, William Chester,	*Calumet.*
Hood, Ben Benight,	*Houghton.*
Hovland, Joseph T.,	*Zumbrota, Minn.*
Howard, Horace H.,	*Ann Arbor.*
Ingle, Hugh Cochrane,	*Princeton, Ind.*
Ives, Lee Emmet,	*Minneapolis, Minn.*
Jackman, Herbert Everard, Ph.B. (Syracuse University),	*East Jordan.*
Jacobson, Jacob Wilho,	*Hancock.*
Janzen, William Frank Henry,	*Marquette.*
Jefferson, Harry Edward,	*Houghton.*
Johnson, Herbert Willis,	*Ishpeming.*
Jolly, Carlos John,	*Painesdale.*
Kelly, Charles Brace,	*Grand Rapids.*
Kiesow, Henry Albert,	*Milwaukee, Wis.*
Killmar, Henry Merton,	*Calumet.*
King, Carl Benton,	*Hancock.*
Kirkpatrick, Marsena Richard,	*Bellingham, Wash.*
Kong, Holme Ho,	*Can Ton, China.*
Koontz, Kinter Kenneth,	*Johnstown, Pa.*
Kruse, Henry Joseph,	*Beacon.*
Kumke, Charles A.,	*Detroit.*
Kuntz, Julius Matthew,	*Freda.*
Langley, Clifton Evans,	*Detroit.*
Langworthy, William Probasco,	*Houghton.*
Lansdowne, Harry M.,	*Greenville, O.*
Lavery, Vaughn Metcalfe,	*Evanston, Ill.*
Ledbetter, Robert Anderson,	*Elizabethtown, Ill.*
Leland, Everard,	*Fenville.*
LeVine, Henry,	*Mt. Vernon, N. Y.*
Lindberg, Carl Otto, B.S. (Michigan College of Mines),	*Houghton.*
Lull, Edward Lawrence,	*Winona.*
McFadden, Joel Parkhurst,	*Chicago, Ill.*
McIntire, Robert,	*Helena, Mont.*
Mace, Henry Arthur,	*Duluth, Minn.*
Maitland, Harvey Keith,	*Negaunee.*

NAME	RESIDENCE
Mallmann, Richard Lee,	*Houghton.*
Marshall, George Bowen,	*New York City, N. Y.*
Matthews, Abe, Jr.,	*Marquette.*
May, Karl Axtell,	*Cambridge, Wis.*
Moore, Howard Warren,	*Cleveland, O.*
Morgan, George Herbert,	*Detroit.*
Morgan, Howard Wall,	*Milwaukee, Wis.*
Muir, Neal Matthew,	*St. Paul, Minn.*
Mullin, Harry D.,	*Sioux City, Iowa.*
Murphy, Fred James,	*Petoskey.*
Nevin, Benjamin C.,	*Porto Rico, Cuba.*
Newton, Charles Edward,	*Brooklyn, N. Y.*
Noble, Leslie Sisson,	*Upper Alton, Ill.*
Nolan, Joseph P.,	*Ishpeming.*
Norcross, Fred Stephenson, Jr.,	*Menominee.*
Olk, Henry John,	*Antigo, Wis.*
Ortiz, Vicente Nicholas,	*Mexico City, Mex.*
Peacock, Ceth D.,	*Chicago, Ill.*
Penberthy, Ira Gladstone,	*Calumet.*
Perkins, William James,	*Norway.*
Pickard, Byron Oscar,	*Omaha, Neb.*
Pittman, Clarence Dane,	*Hancock.*
Platt, Frederick Clark,	*Flint.*
Pollock, Frank Albert,	*Minneapolis, Minn.*
Pratt, John Brooks,	*Milwaukee, Wis.*
Presho, Edward Webb, B.A. (Tufts College),	*Los Angeles, Cal.*
Quinn, Clement Kruse,	*Beacon.*
Randolph, George Oscar,	*Marquette.*
Reeder, John Henry,	*Calumet.*
Reynolds, Frank Arthur,	*Detroit.*
Rice, Eugene Roche,	*Wickenburg, Ariz.*
Richards, James F.,	*Houghton.*
Ricks, Glen Armour,	*Taylorville, Ill.*
Roberts, William H.,	*Painesdale.*
Robertson, Jasper Thistlie,	*Chicago, Ill.*
Roe, Ira Smith,	*Detroit.*
Roscoe, Harry L.,	*Traverse City.*
Royce, Ward,	*Hancock.*
Rumsey, Edward Prole,	*Batavia, N. Y.*
St. Germain, Joseph,	*Hubbell.*
St. Vincent, Bert,	*Soudan, Minn.*
Scallon, Edward Philip,	*Hancock.*
Schuettenhelm, John Bernard,	*Detroit.*
Seaman, Wyllys Arthur,	*Houghton.*
Seifert, John A.,	*Houghton.*
Sharp, Harry,	*Houghton.*

NAME	RESIDENCE
Shedwick, William J., Jr.,	*Philadelphia, Pa.*
Sherburne, E. Bertrand,	*Houghton.*
Shove, Byron Douglass,	*Ironwood.*
Sipprell, James Garfield, B.A. (Acadia College),	*St. John, N. B.*
Smith, Carl Getchell,	*Kearsage.*
Smith, Frank Julius,	*Grand Rapids.*
Smith, Harold Kenneth,	*Rockford, Ill.*
Smith, Ralph Loveland,	*Mexico City, Mex.*
Sokup, Charles Thomas,	*Grand Rapids.*
Sparks, Benjamin Franklin,	*Grand Rapids.*
Sperr, J. Dana,	*Houghton.*
Sproat, Erl L.,	*Grand Rapids.*
Stammler, George Fronheiser,	*Johnstown, Pa.*
Stevenson, John Edwin,	*Detroit.*
Stodden, Richard Harry,	*Beacon.*
Sullivan, Joseph Raymond,	*Escanaba.*
Theobald, Joseph Arthur,	*Baraga.*
Thoms, James Ezra,	*Three Rivers.*
Thoenen, John Roy,	*Sault Ste. Marie.*
Tietsort, Abram Roy,	*Detroit.*
Torbert, James Burnett,	*Jersey Shore, Pa.*
Tregoning, Richard Alfred,	*Hubbell.*
Trembath, James,	*Butte, Mont.*
Tuttle, Jay, Jr.,	*Astoria, Ore.*
Van Evera, Wilbur,	*Marquette.*
Van Stratum, Byron Vedder,	*Hurley, Wis.*
Wagner, John Ezra,	*Belding.*
Wallace, Russel Bruce,	*Oak Park, Ill.*
Wanvig, John Daniel,	*Milwaukee, Wis.*
Wealton, George Jerome,	*Hancock.*
White, Paul Marcy,	*Brooklyn, N. Y.*
Williams, Jerome Joseph,	*Chicago, Ill.*
Williams, Leslie Allers,	*Saginaw.*
Wilson, Frank Brown,	*Houghton.*
Wing, Homer William,	*Ionia.*
Wold, Adolph Nicholas,	*Hancock.*
Wood, Ely Cockle,	*Peoria, Ill.*
Wood, Robert Franklin, B.A. (Williams Coll.), B.S. (Michigan College of Mines),	*Blandford, Mass.*
Wright, David Morgan,	*Escanaba.*
Wright, Harry Anson,	*Iron Mountain.*
Young, Arthur Waldemar,	*Houghton.*

[redacted]

SUMMARY OF STUDENTS, 1906-1907

BY STATES AND COUNTRIES.

Arizona	1
California	1
Canada	1
China	1
Connecticut	1
Illinois	20
Indiana	1
Iowa	1
Japan	1
Kentucky	1
Massachusetts	1
Mexico	3
Michigan { Upper, 83 / Lower, 44 }	127
Minnesota	13
Montana	6
Nebraska	1
New Mexico	1
New York	7
Ohio	4
Oregon	1
Pennsylvania	7
Porto Rico	1
Texas	1
Utah	2
Washington	1
Wisconsin	11
Total	216
Average Age of Students, 1906-07	22½ years

[redacted]

SUMMARY OF ENROLLMENT DURING EXISTENCE OF THE COLLEGE

The number of new students who entered, the total enrollment, and the number of graduates sent out for each year of the existence of the College, are as follows:

Year	86–7	87–8	88–9	89–90	90–1	91–2	92–3	93–4	94–5	95–6	96–7	97–8	98–9	99–00	1900–01	1901–02	1902–03	1903–04	1904–05	1905–06	1906–07
New students	23	15	16	15	46	40	45	17	49	43	82	33	42	54	71	95	92	101	99	101	75
Total attendance	23	29	40	35	61	78	101	82	94	94	140	122	116	121	146	197	221	238	223	234	216
Graduates	..	7	6	5	4	..	8	17	22	18	5	18	24	19	25	24	42	41	43	50	...

RECORD OF GRADUATES

The College publishes a Record of Graduates, a booklet which gives as accurately as possible the various positions held by graduates up to and including the Class of 1905.

Below is given a record of the graduates of 1906 so far as known by the College:

ANDERSON, GEORGE ANDREW, B. S., E. M., 1906. Assistant U. S. Deputy Mineral Surveyor, Deadwood, S. D. Assistant Superintendent and Mining Engineer at Calumet & Montana Mining Co., Baker, Idaho. *Baker, Idaho.*

ANDERSON, MERTON BAIRD, E. M., 1906. Engineer, Herminia Mining Co., Massey, Ont., Can. (*Deceased*, 1906.)

ANDREWS, WORTH BRIGGS, E. M., 1906. With the International Harvester Co., Hibbing, Minn. With Combination Mining Co., Goldfield, Nev. *Goldfield, Nev.*

BAILEY, ALFRED COLIN, E. M., 1906. Looking over mineral lands in Ontario. Superintendent Abitibi and Cobalt Mining Co., Gillies Depot, Ontario (Cobalt District). *Gillies Depot, Ont.*

BAKER, ALBERT MEANS, E. M., 1906. Assistant Engineer, Cerro de Pasco Mining Co., Smelting Department, La Fundicion, Peru, S. America. *La Fundicion, Peru.*

BARABE, CLIFFORD ALOYSIUS, B. S., 1906. Assistant in Metallurgy, Michigan College of Mines. Timberman, Lake Shaft, Cleveland Cliffs Iron Co., Ishpeming. *Ishpeming.*

BENNETT, THOMAS HERBERT, B. S., E. M., 1906. Assistant Engineer, Copper Range Consolidated Mining Co., Painesdale. *Houghton.*

BUCHANAN, JEROME ROBINSON, E. M., 1906. Structural Designer, Compania de Real del Monte y Pachuca, Pachuca, Mex. Chief Draughtsman, Guanajuato Reduction and Mines Co., Guanajuato, Mex. *Guanajuato, Guanajuato, Mex.*

BURHANS, HARRY HATCH, E. M., 1906. *Moctezuma, Sonora, Mex.*

BURKE, GILBERT M., E. M., 1906. Engineer, Lake Superior Mining Co., Shullsburg, Wis. General Manager, Bullfrog Mining Co., Joplin, Mo. *Joplin, Mo.*

COREY, GEORGE WATSON, B. S., 1903, E. M., 1906. Instructor Department of Geology, Michigan College of Mines, Houghton. Instructor Department of Geology, University of Wisconsin, Madison, Wis. *Madison, Wis.*

DERWIN, LEWIS THOMAS, E. M., 1906. Assistant Engineer, Cerro de Pasco Mining Co., Smelting Department, La Fundicion, Peru, S. Amer. *La Fundicion, Peru.*

DEWILDE, FELIX JULIUS, E. M., 1906. Weighmaster, Arizona Smelting Co., Humboldt, Ariz. Assistant Superintendent, De Sota Milling Co., Humboldt, Ariz. Assistant Mining Geologist, Calumet and Arizona Mining Co., Bisbee, Ariz. *Bisbee, Ariz.*

DIETZ, CHRISTIAN, B. S., 1906. With New York Central Railroad, Watertown, N. Y. *Mechanicsburg, Pa.*

DOWNING, ROBERT LEE, B. S., E. M., 1906. Engineer and Chemist, Inland Steel Co., Hibbing, Minn. *Hibbing, Minn.*

DUNCAN, LAWRENCE GRANT, E. M., 1906. Engineer, Shattuck Mining Co., Bisbee, Ariz, *Bisbee, Ariz.*

EDYVEAN, EDMUND H., B. S., 1906. Engineer, Jones Exploration Co., Iron Mountain, Mich. Engineer and Chemist, Commonwealth Iron Co., Commonwealth, Wis. *Commonwealth, Wis.*

FURBECK J. PHILIP, B. S., E. M., 1906. Engineer for "Arctic Coal Co." (Ayer & Longyear) at Advent Bay, Spitzbergen, Norway. Engineer for The Montezuma Mine, Inc., at Miramar, Costa Rica, C. A. *Miramar, Costa, Rica, C. A.*

GRAHAM, ERNEST R., B. S., 1906. Student, Michigan College of Mines. *Houghton.*

GRANT, WILBUR HENRY, E. M., 1906. Instructor in Mineralogy, Michigan College of Mines. *Houghton.*

HAMILTON, ORR ROSS, E. M., 1906. Assistant Engineer, Cerro de Pasco Mining Co., Smelting Department, La Fundicion, Peru, S. Amer. Assayer, Sociedad de Minas de Cobre de Cutter Cove. *Cutter Cove, Chili, S. A.*

HARTNESS, JAMES CAMERON, E. M., 1906. Assistant in Mine Surveying and Mining, Michigan College of Mines, Houghton. Mining Engineer, The Tombstone Consolidated Mines Co., Ltd., Tombstone, Ariz. *Tombstone, Ariz.*

HASSELBRING, ALBRECHT, E. M., 1906. Mining Engineer and Chemist, Illinois Iron Mining Company, North Freedom, Wis. *North Freedom, Wis.*

HENDERSON, ENOCH, B. S., 1905, E. M., 1906. Assistant Mining Engineer, Verona Mining Co., Stambaugh, Mich. Superintendent, Copper Crown Mining Co., Matchwood, Mich. *Matchwood.*

HERMANN, CHARLES FREDERICK, B. S., 1906. Student, Michigan College of Mines. *Houghton.*

HITCHCOCK, CLARENCE HORACE, E. M., 1906. Instructor in Mineralogy, Michigan College of Mines. *Houghton.*

HOUSTON, FRED KENNEDY, E. M., 1906. Furnace Foreman, Capillitas Copper Co., Muschaca. *Muschaca, Argentina, S. A.*

HUSTON, MILTON BENJAMIN, E. M., 1906. Mill Superintendent, The Mexican Investment and Development Co., Autlan, Jalisco, Mex. *Autlan, Jalisco, Mex.*

KELLEY, FRANK ARTHUR, B. S., E. M., 1906. Assistant Engineer, Oliver Iron Mining Co., Ishpeming. Engineer in Charge, Champion Mine, Oliver Iron Mining Co., Beacon, Mich. *Beacon.*

KINGSTON, CARL J., B. S., 1906. Assayer, Cerro de Pasco Mining Co., Cerro de Pasco, Peru. *Cerro de Pasco, Peru.*

KLINGLUND, FRANK DAVID, B. S., 1905, E. M., 1906. Engineer and Chemist, Commonwealth Iron Co., Commonwealth, Wis. Assistant Superintendent, Brule Mining Co., Stambaugh, Mich. *Box 207, Stambaugh.*

KRATZ, ARTHUR MURRAY, B. S., 1906. Draughtsman, DeBeers Mining Co., Kimberley, S. Africa. *Kimberley, S. A.*

LAND, CHARLES HENRY, B. S., 1906.

LINDBERG, CARL OTTO, B. S., 1906. With Carpenter and Brennon, City of Mexico, Mex.
c/o Room 519, La Mutua, Mexico, D. F. Mex.

McCOLLOM, CHARLES ROLFE, B. S., E. M., 1906. Miner, Copper Queen Mine, Bisbee, Ariz. Rodman and Surveyor, Calumet and Arizona Mining Co. Inspector and Assistant Geologist, Calumet and Arizona Mining Co., Bisbee, Ariz. Assistant Field Geologist for Northern Mexico, Guggenheim Exploration Co., Bisbee, Ariz.
P. O. Box 297, Bisbee, Ariz.
Permanent address: *520 Forest Ave., Minneapolis, Minn.*

McKILLICAN, JAMES ANGUS, B. S., 1906. Manager, Michigan and Montana Development Co., Wickes, Mont.
Wickes, Mont.

MANLY, ADEN J., B. S., E. M., 1906. Assistant Manager, Paymaster Mine, Gold Rock, Ont., Can. *Gold Rock, Ont., Can.*

NETZORG, LEON ZELAZNY, B. S., E. M., 1906. Mining Engineer, Manitou and Frontenac Mining Companies, Delaware Mine, Mich. Foreman, National Plant, American Smelting and Refining Co., South Chicago, Ill.
South Chicago, Ill.

PATTISON, WILLIAM BROOKS, E. M., 1906. Mining Engineer, Pioneer Mines Co., Silver City, Idaho. Mining Engineer and Chemist for Commonwealth Iron Co., Commonwealth, Wis. Assistant Superintendent, Empire Iron Co., Negaunee, Mich. *Negaunee.*

PEARCE, EDWARD J., B. S., E. M., 1906. Furnace Foreman, Capillitas Copper Co., Muschaca. *Muschaca, Argentina, S. A.*

POHLE, LOUIS H., E. M., 1906. Engineer, Shannon Copper Co., Metcalf, Ariz. Engineer, Arizona Copper Co., Clifton, Ariz. *Clifton, Ariz.*

ROSE, ARTHUR HERBERT, B. S., 1906. Superintendent, Anglo-American Mining and Milling Co., Rush, Ark. *Rush, Ark.*

SCALLON, EDWARD PHILIP, B. S., E. M., 1906. Assistant to V. S. Hillyer in construction of Marquette Co. macadam roads. Post-graduate Student and Assistant in Metallurgy Laboratory, Michigan College of Mines. Assistant Mining Engineer, Winona, King Philip and Challenge Mines, Winona, Mich. *Winona.*

SCHAUS, OLIVER MONTELL, B. S., E. M., 1906. Practical work in Furnace Room, Highland-Boy Smelter, Murray, Utah. Sampler, Pioneer Sampling Works, Sandy, Utah. Assistant (Chemist, Metallurgist and Assayer), Boston & Montana, C. C. & S. Mg. Co.'s Smelter, Great Falls, Mont. *Great Falls, Mont.*

SCHUBERT, GEORGE P., B. S., 1905, E. M., 1906. Instructor in Civil and Mining Engineering, Michigan College of Mines. *Houghton.*

SEGSWORTH, WALTER EDGAR, E. M., 1906. Assistant Engineer, Centennial and Allouez Mines, Allouez, Mich. *Toronto, Can.*

SIPPRELL, JAMES GARFIELD, B. S., 1906. Mining Engineer, Montreal Mining Co., Montreal, Wis. *Montreal, Wis.*

SLAUGHTER, WILLIAM FROST, B. S., E. M., 1906. Compassman, Geological Department of the Oliver Iron Mining Co. Mining Engineer with the Republic Iron Co. at Republic, Mich. *Republic.*

SMITH, ALFRED LEGGETT, B. S., E. M., 1906. Chemist, Brotherton Iron Mining Co. and Sunday Lake Iron Co., Wakefield, Mich. Engineer, Brotherton Iron Mining Co., and Sunday Lake Iron Co., Wakefield, Mich.
Box 274, Wakefield.

STADLER, GEORGE H., E. M., 1906. Draughtsman with the Detroit United Railway, Detroit, Mich. *585 18th St., Detroit.*

STEELE, JOHN WILLIAM, B. S., 1906. Chemist with Lake Shore and Michigan Southern R. R., Collinwood, O. Engineer with Buffalo & Susquehanna Iron Co. Hibbing, Minn. Engineer with New York State Steel Co., Virginia, Minn. *Virginia, Minn.*

STEINBACH, HARRY PHILIP, B. S., E. M., 1906. Chemist, Quincy Mining Co., Hancock. Mining Engineer, Republic Iron and Steel Co., Virginia, Minn. *Virginia, Minn.*

WALKER, MARSHALL STARR, B. S., 1905, E. M., 1906. Instrument man for City Engineer of Hancock, Mich. Solution man, Ajuchitlan Mining & Milling Co., Ahorcado, Queretaro, Mexico. Solution man; Assayer, for A. Maitland, Maitland, S. D. Assistant to J. V. N. Dorr, Metallurgical Engineer, Lead, S. D. Construction of Slime Process, Southern Cross Gold Mine, Cable, Mont. *Cable, Mont.*
Permanent address: *333 E. Fuller St., Grand Rapids.*

WEGEFORTH, CHARLES PARKER, E. M., 1906. Engineer, Penn-Wyoming Copper Company, Encampment, Wyo.
P. O. Box 230, Encampment, Wyo.

WOOD, ROBERT FRANKLIN, B. S., 1906. On the Engineering Corps of the Guanajuato Development Co., Guanajuato, Mex. *Apartado 25, Guanajuato, Mex.*

WOODWORTH, IRWELL NEWTON, E. M., 1906. Assistant Mining Engineer, Verona Mining Co., Stambaugh, Mich.
Stambaugh.

Index

EXPLANATION OF TABLES AND MAPS

TABLES.

Table I shows the term or terms in which each subject is taught, its proportionate credit in tenths of a unit, the number of times each week that the student must appear in class-room for recitation or lecture, and the total number of hours each week an average student is expected to put upon the subject. This total includes both laboratory and study time with the class-room time. The time spent at the College includes both the recitation and laboratory hours.

Tables II, III, IV, and V show the particular hours in each week at which the student taking a given subject meets the instructor in the class-room for recitation or lecture.

These tables do not show the laboratory hours, which must be arranged with the instructors having charge of the work. These may differ widely for different students.

In choosing his subjects for any year the student must avoid conflicts; that is, he must not choose two subjects which have a common recitation or lecture period.

No hour table is given for the practice courses of the summer term, the practice work in Mine Surveying and Mining (R 3), nor the excursions to the mines, mills and field in the courses R 1 (Principles of Mining), G 2 (Metallurgy), M 11 (Mechanical Engineering II.) S 2 (Ore Dressing) and Y 1 (Principles of Geology). While pursuing any one of the practice courses the student devotes to it his whole time. The excursions in the other courses are arranged for while the courses are in progress. Therefore no hour tables are necessary.

MAPS.

To make clear the fact of the location of the College of Mines in the midst of active mining operations, two maps are shown.

The first gives a detailed exhibit of the Portage Lake Mining District, which forms the immediate vicinity of the College. Most of the active copper mines within the territory covered by this map are indicated on it.

The second is a general map of the mineral districts of the Upper Peninsula. It shows the various iron and copper ranges which are accessible from the College. No attempt has been made to indicate the different mining districts of the Copper Range, nor the subdivisions of the Iron Ranges.

E 1.

HEDULE ERM.

C EACH SUBJECT EACH WEEK

-1908.

ematics

Petrog in

Miner

Biol

Ore